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This volume outlines a system for effective planning in higher education. The system integrates management and program planning, physical plant planning, and financial planning into a single process designed to support institutional management and decision making at all administrative levels. Because successful planning is a process, procedures for annual update and review are discussed. The report concludes that (1) a good total planning system should become a keystone of institutional management, (2) the creation of a top level administrative position of planning and analytical studies is necessary to the successful implementation of planning, (3) the planning process can and should be supported by a strong base of quantitative data, and (4) planning must be dynamic and continuing. A related document is EA 001 725. (TT)

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VOLUME ONE

GUIDELINES FOR PLANNING IN COLLEGES AND UNIVERSITIES

PLANNING SYSTEM

EA 001 724

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GUIDELINES FOR PLANNING IN COLLEGES AND UNIVERSITIES

VOLUME ONE · PLANNING SYSTEM

Report Developed For

THE COORDINATING BOARD • TEXAS COLLEGE AND UNIVERSITY SYSTEM

By
Dr. Charles Pinnell • Project Director

and
Mr. Michael Wacholder • Associate Project Director

Texas A&M University • January 1968

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In creating the Coordinating Board, Texas College and University System, the 59th Texas Legislature directed the Board to "require and assist the public senior colleges and universities, medical and dental units, and other agencies of higher education in developing long-range plans for campus development."

An early step by the Coordinating Board in carrying out this legal mandate was to conduct a statewide survey of the status of institutional master planning in Texas. In January, 1967, the Board published a report indicating that many colleges and universities in the State did not have master plans which could be considered comprehensive in scope.

As a result, the Coordinating Board entered into a contract with Texas A&M University to prepare a model system for planning in colleges and universities. The volumes which make up the "Guidelines for Planning in Colleges and Universities" are the product of this contracted project.

Student enrollment in Texas colleges and universities will increase rapidly and dramatically during the next decade, and the importance of sound planning cannot be too strongly emphasized.

The process of planning described in these volumes focuses on the creation of a system to permit institutions to identify that which is innovative and unique about their educational program and objectives and to plan in depth within the context of their institutional objectives. Master planning is conceived in these volumes as encompassing the total decision-making framework of the institution. Under such a condition, an institutional master plan becomes a complex document in which the design and location of buildings is but one of the components.

The distribution of these "Guidelines for Planning in Colleges and Universities" by the Coordinating Board is not intended to standardize all planning procedures in Texas higher education or to force colleges and universities into a lockstep approach, physically or otherwise. Rather, the purpose of the volumes is to provide to both public and private institutions illustrations and suggested approaches. We ask that the volumes be accepted in this context.

The Coordinating Board staff expresses deep appreciation to Dr. Charles Pinnell, Michael H. Wacholder, and other members of the research staff at Texas A&M University for the work they applied directly to this study and the direction they gave to the consultants providing assistance to them.

J. K. Williams
Commissioner

ACKNOWLEDGEMENTS

The research and development work that has gone into the preparation of "Guidelines for Planning in College and Universities" has been a most challenging and rewarding experience. The staff members of this study are sincerely grateful for the opportunity to have worked on the project and wish to express their gratitude to those who made it possible.

First, our thanks are extended to the Coordinating Board, Texas College and University System, for sponsoring this research project. The group, under the direction of Dr. Jack K. Williams, is providing significant leadership to higher education in Texas, and we are proud to have been associated with their work. Mr. Kenneth H. Ashworth, Assistant Commissioner for Federal Programs and Facilities Planning and Mr. William J. Martin, Director of Facilities Planning of the Coordinating Board Staff provided support and assistance in all aspects of the study and contributed significantly to the research effort.

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Dr. Charles Pinnell
Project Director

PROJECT STAFF

CHARLES PINNELL – Project Director
B.S., Civil Engineering, Texas Technological College, 1952;
M.S., Civil Engineering, Purdue University, 1958;
Ph.D., Management and Engineering Science, Northwestern University and Texas A&M University, 1964.

MICHAEL H. WACHOLDER – Associate Project Director
B.S., Landscape Architecture, University of California at Berkley, 1965;
M.S., Urban Planning, Texas A&M University, in progress.

LESTER WOOD – Computer Systems for Space Utilization and Reporting
B.A., Mathematics, Texas A&M University, 1959;
M.S., Computer Science, Texas A&M University, in progress.

ELLIOTT BRAY – Automated Scheduling of Teaching Facilities, Management Information Systems
B.S., Mathematics, Lamar State College of Technology, 1962;
M.S., Computer Science, Texas A&M University, 1967.

MEL H. LASELL – Facilities Reporting, Management Planning
B.A., Business Administration, Texas A&M University, 1967;
M.S., Management, Texas A&M University, in progress.

JOHN REGLIN – Traffic Planning
B.S., Civil Engineering, University of Texas at Arlington, 1967;
M.S., Civil Engineering, Texas A&M University, in progress.

ROBERT DUNPHY – Traffic Planning
B.S., Civil Engineering, Catholic University, 1965;
M.S., Civil Engineering, Texas A&M University, in progress.

ROBERT BRADLEY - Quality Analysis for Facilities
B.S., Building Construction, Trinity University, 1966;
M.S., Urban Planning, Texas A&M University, 1968.

RAY ABBOTT - Physical Plant Planning and Publications
B. Arch., Texas A&M University, 1966;
M.S., Urban Planning, Texas A&M University, in progress.

JOE DAVIS - Space Utilization, Management Planning
B.S., Industrial Technology, Texas A&M University, 1967;
M.S., Computer Science, Texas A&M University, in progress.

SUPPORTING PERSONNEL

DR. VERGIL STOVER
PROFESSOR JAMES GARDNER
CLIFF GUILLETT
DAVID KEATING
RONALD PERRY
MRS. PAM ROWE
MRS. LYNN WILLIAMS

PUBLISHERS

WALLACE PRINTING CO.
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PROJECT CONSULTANTS

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INTRODUCTION

BACKGROUND

The problems created by the need to furnish higher educational facilities for more than half the nation's college age population by 1975 are numerous and significant. The best possible management and planning will be required in colleges and universities if this challenge is to be met within the financial constraints that will exist.

The field of college and university administration is now entering what has been termed a "Managerial Revolution in Higher Education."[1] The hallmark of this managerial revolution is the emphasis placed upon quantitative decision-making and objective management.

The age of quantitative decision-making had its inception during World War II, when the techniques of systems management and scientific decision-making were developed to improve our ability to wage war. Here, for the first time, teams of scientists were assembled to develop techniques that would maximize the probability that a given decision and the resulting action would be correct and successful. This resulted in quantified techniques for bombing raids, submarine deployment, and numerous other aspects of war strategy.

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[1] *The Managerial Revolution in Higher Education,* Francis E. Rourke and Glenn E. Brooks, The John Hopkins Press.

At the close of the war, the principles of operations research were well defined, and a new scientific approach to decision-making and management was in the making. Industry quickly adapted these techniques to their operations and initiated work to develop new innovations of their own. In the early sixties, the systems management approach was introduced into the federal government and applied to the management of the Defense Department.

Those responsible for adminstration in higher education must critically examine these new managerial techniques and develop applications that are practical and useful in meeting the significant challenges that lie ahead. The development of a systems approach to institutional planning that would provide college and university administrators with a vital information system for decision-making and program implementation deserves a top priority in this regard.

The Coordinating Board, Texas College and University System, in February of 1967, provided the funds and direction for a study aimed at developing guidelines for effective planning in institutions of higher education. This study was to investigate the latest techniques of scientific management and the problems of institutional administration and planning and develop a planning system applicable to the needs of colleges and universities. This report and subsequent volumes are the result of this effort.

PLANNING REQUIREMENTS

Probably the greatest problem of management today is that of coping with the rapid rate of change. As the rate of change increases and our environment becomes more complex, it becomes increasingly difficult to predict the future and its requirements with any degree of reliability.

Modern corporations have found that they must plan effectively if they are to stay abreast of competition in today's competitive economy. In order to meet the challenge of change, modern industry has developed dynamic planning methods which place heavy reliance on quantitative data systems and objective management.

While the rate of change is a problem for industry, it is an even greater problem for institutions of higher education. A great educational institution must not only keep pace with change, it must be an exponent and edifier of change. Thus, educational institutions must develop and utilize superior planning techniques that make maximum use of all knowledge at hand and involve and utilize the varied skills of all personnel.

There has been a great tendency in the past for institutional planning to emphasize physical plant planning or "campus planning" and to omit serious consideration of management and program planning and financial planning. This omission weakened the ability for objective planning and often produced plans which were neither related to the goals of an institution nor financially feasible. Thus, the planning effort often furnished the educational institution with a "master plan" which stated where the institution should be at some future time but unfortunately did not specifically establish why it wanted to be there, nor how it was going to get there.

Another problem associated with past planning efforts has been the emphasis on producing a "plan" rather than a "planning process." This "plan" was effective for one point in time but soon became outdated and unadaptable to changing conditions. This defect has often resulted in the entire planning product becoming useless in a few years.

This project has sought to identify the problems and defects associated with past planning efforts and to devise a planning system which would eliminate or minimize them. This consideration has

identified the following factors which have furnished the basic direction for the development of guidelines for institutional planning:

(1) The emergence of scientific management techniques which can be applied to educational administration,

(2) The recognition of planning as a vital and necessary tool of institutional administration,

(3) The recognition of the need for a total systems concept of institutional planning.

(4) The recognition of the need for a continuing planning process,

(5) The recognition of the need for logical, systematic procedures for institutional planning, and

(6) The recognition of the need for the development of plans which are financially feasible.

PROJECT SCOPE

It is necessary to emphasize initially that the following procedures and recommendations are intended to serve as guidelines for institutional planning. All educational institutions are unique in some respect, and any given institution would, no doubt, desire to modify the suggested procedures to fit specific requirements. A rigid and routine application of the following techniques by a specific institution is, therefore, not intended nor recommended.

It is believed, however, that the material provided in this and subsequent volumes presents basic guidelines from which a desirable and logical planning process can be developed for any given institution of higher education regardless of size or program offerings. It should be noted that the

study considered the planning requirements of Junior Colleges, Four Year Colleges and Universities and sought to develop planning guidelines applicable to all types of educational institutions. However, it was found that planning for a major university required the most comprehensive consideration, and therefore this type institution will be utilized as the framework for discussion. To simplify the presentation, the term "university" will be used throughout the following report, and the reader should, therefore, be aware of the substitution of the single word "university" in many cases for the multiple meaning of "college and university".

PROJECT ORGANIZATION

A desired planning process for an educational institution is comprised of a rather extensive system of interrelated and interdependent efforts. The total planning effort can logically be divided into three major phases which are listed as follows:

(1) Management and Program Planning,
(2) Physical Plant Planning, and
(3) Financial Planning.

A successful planning system will contain all these major phases and will finally merge them into a single product. The major phases as listed provide a good framework for organization and this report will discuss each phase individually.

FIGURE 1 · COLLEGE AND UNIVERSITY PLANNING SYSTEM

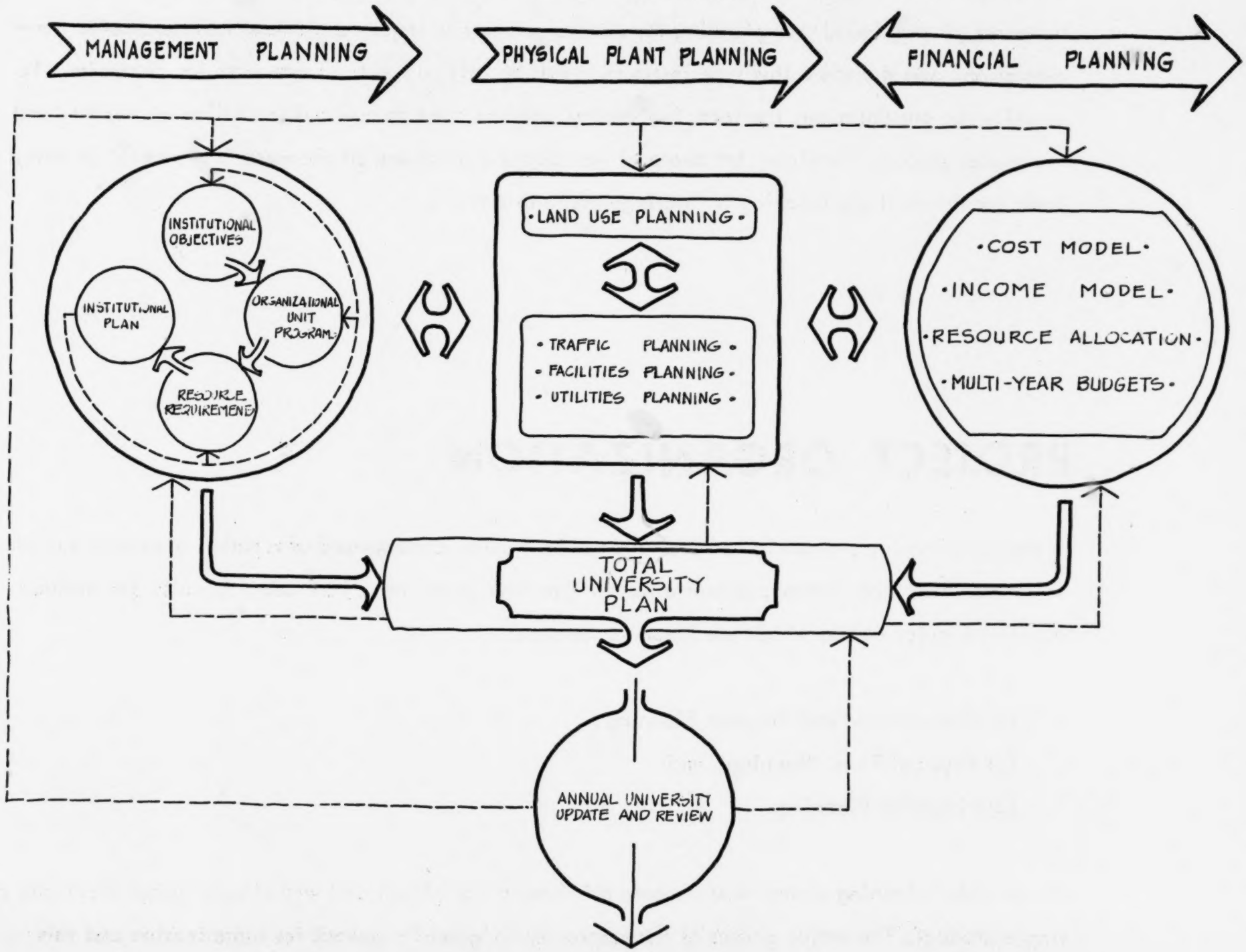


Figure 1 provides a graphic illustration of the total planning system that was developed. This illustration will be utilized throughout this report to remind the reader of the total planning system and to assist him in relating the material in the various sections of the report to the total system.

PROJECT PRESENTATION

The materials developed as a result of this project were so voluminous that it was desirable to utilize several volumes for their presentation. The presentation of the total research effort has been divided into two basic areas which are

I. Planning System
II. Planning Techniques

This first volume of the material presents the Planning System. The purpose of this material is to present the concept and format of the total planning system which has been developed. The emphasis in this volume is on a brief, well-illustrated presentation that allows the reader to review and conceive the total planning system with a minimum of effort.

The additional volumes are labeled Planning Techniques. The purpose of these volumes is to furnish detailed descriptions and illustrations of some of the techniques that have been and can be developed to complete the various phases of the planning system. These volumes are as follows:

Volume II - Management and Financial Planning
Volume III - Physical Plant Planning - Land Use and Traffic
Volume IV - Physical Plant Planning - Facilities Studies
Volume V - Physical Plant Planning - Utility Studies

In addition to the above volumes, a sixth volume was developed by the architectural firm of Caudill, Rowlett and Scott, Houston, Texas. This volume provides guidelines for the implementation of building programs and is listed as follows:

Volume VI - Physical Plant Implementation - Procedural Guidelines for Building Design and Construction

The remainder of this volume is devoted to the total planning process. Of the following five sections, the first three deal with Management and Program Planning, Physical Plant Planning, and Financial Planning. The fourth section relates these three components of planning to the total university plan, and the final section discusses the procedures for annual update and review.

TIME SPAN

Selecting a desirable time span for planning is a rather difficult problem. The rapid rate of change that is present in today's environment can significantly affect the accuracy of long-range projections. Yet an institution must look several years into the future if its planning effort is to be effective and meaningful.

The approach which will be recommended in this study is one of planning for several future points in time and of relying on a continuous planning and update system to stay abreast of the effects of change. Specifically the following time spans will be considered as indicated:

Long-Range Planning Horizon - A long-range horizon of 10 to 30 years is necessary to the consideration of some aspects of the planning effort. Particularly in regard to Physical Plant Planning, it may be necessary to consider a long time span in which the life of buildings, mechanical systems, and other physical entities may expire. The 10-30 year viewpoint of planning would be one of generalities which affords some conclusions of what may exist and how it relates to the short-range aspects of the plan. For example, Physical Plant Planning for an old university for which the life of a majority of its buildings will expire within the next 15 years would be vastly different than for a new university whose physical plant may have a life span of 30 years or more.

Ten Year Plan - This would be the maximum time span for specific projections. Even with the short time span, it is to be expected that factors projected over this period will be subject to considerable change. The basic purpose of the 10-year projection is to establish good estimates of probable requirements at that point in time. This period of time will permit the establishment and realization of construction programs which may take several years to complete.

Five-Year Plan - Good accuracy of projections should be expected for this time span in the overall planning effort, and it should furnish the basis of the projected planning. This period is short enough to permit realistic projections and long enough to provide the necessary lead time for developing and implementing plans of action.

One-Year Plan - The one year plan is basic to the operation of an institution and is provided for this purpose. It provides data for budgeting, staffing, and other similar functions vital to the year-to-year operation of the university.

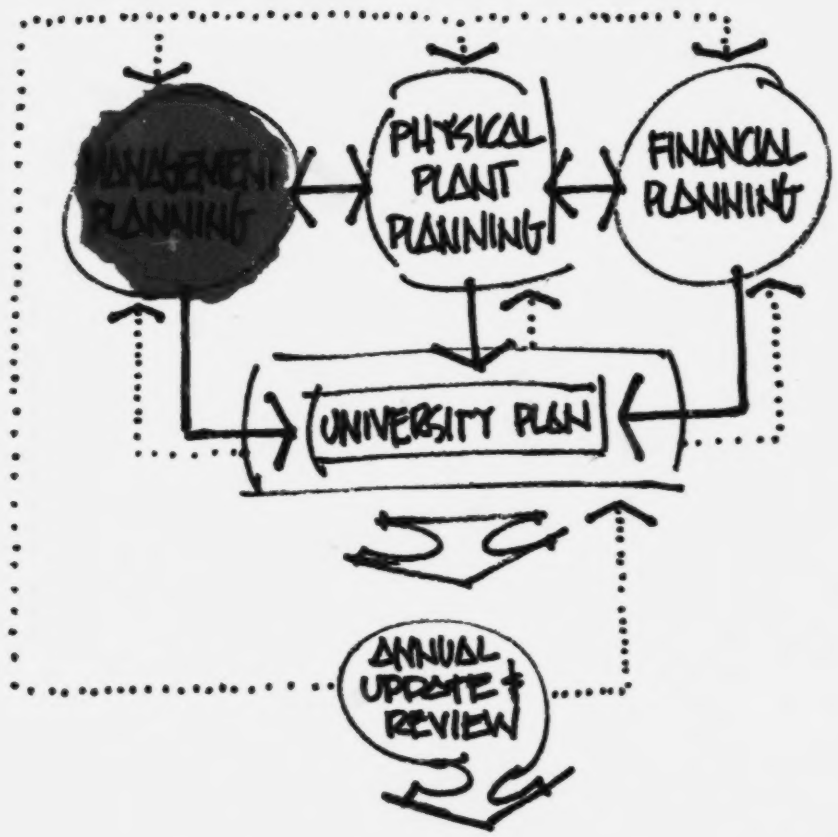
Dynamic System - The rapid rate of change present today dictates the need for a dynamic and continuous planning process. It is therefore recommended that the One, Five, and Ten Year Plans be reviewed, updated, and projected each year. This would enable an institution to react to changes and to maintain advance planning periods.

COMMUNITY CONSIDERATIONS

The considerations relative to a community within which a given institution exists or will be constructed should be given some attention at this point. If the community is small, the university may be a dominant factor in the socio-economic environment. In this case the community may be very dependent upon the university for direction and support. If the community is large, the situation is reversed, and the university may draw support and direction from the community.

In either case, a strong spirit of cooperation and communication should exist between officials of the university and the community. The strong relationship that exists between university and community planning will be discussed within this report relative to such items as utilities, traffic, and housing. The university plan should provide a logical means of good communication between the two bodies as they seek to solve mutual problems.

MANAGEMENT AND PROGRAM PLANNING



The Management and Program Planning phase must be the initial effort in the planning process as the results developed from this effort are vital to the other phases. As stated previously, a weak link in previous institutional planning procedures has been the failure to identify the basic objectives of an institution and to develop the entire planning process around the attainment of these desired objectives.

The planning process for which guidelines will be outlined in this report is developed on the basic concept of "management by objective" and has been developed to provide a basic tool to assist the administration of a given educational institution in attaining selected objectives.

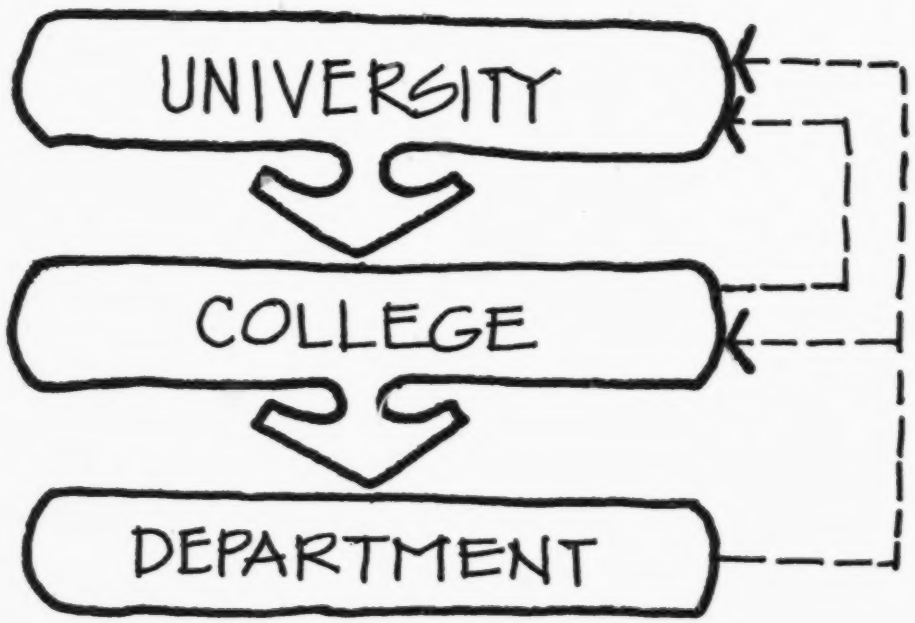
UNIVERSITY OBJECTIVES

The first step in the Management and Program Planning phase is the establishment of university objectives. These objectives must specifically define the desired attainments of a given university. Clear channels of communication must also be established for conveying the objectives of the university and for assigning functional responsibilities for objective accomplishment at all levels of the university.

The task of setting objectives is a difficult one for university administrators and one which cannot be completely delegated. Faculty, staff, students, and information sources external to the university can and should be utilized to develop data and information pertinent to the definition of objectives, but the final specific objectives must be established and approved by the administration of an institution and there must be a strong coordinated commitment to the attainment of these objectives.

The development of objectives should result from an iterative process of consultation and review at the three major levels of university operation. These levels illustrated below are:

(1) University,
(2) College, and
(3) Department.



Since the perspective of the overall university is best at the top level of administration, it is recommended that the procedure of objective review and formulation be initiated at the presidential level. A draft of desired objectives could be assembled for review and modification by an executive committee and this document then passed down to the lower organizational levels for further review and modification. It is deemed vital that the objective setting procedure involve personnel at all organizational levels before final specific objectives are established.

CONTENT

The objectives of a given institution can be expected to be somewhat unique to that institution. Generally, these objectives will be established in the following program areas:

(1) Teaching,
(2) Research,
(3) Public Service and/or Extension.

Some of the more general items for which objectives will be needed are outlined as follows:

(1) Teaching

Instructional Programs - Definition of specific programs to be pursued during planning period;

Organization - Definition of administrative organization. Includes development of new departments, schools or colleges;

Program Level - Includes definition of objectives for undergraduate and graduate programs;

Admissions Policy - Definition of admission standards. Permits the development of specific enrollment estimates by department, college or school, and for the total university;

Special Programs - Definition of objectives for the creation or expansion of special programs such as special learning centers, institutes, etc.

(2) Research

Research Programs - Definition of specific areas where strengths exist or where development is desired. Delineation of areas of research effort;

Funding Level - Selection of goals for research funding. Total dollar volume of research per year;

Organization - Definition of organization for research administration;

Special Programs - Development of research centers or special programs.

(3) Public Service and/or Extension

Programs - Definition of the desired programs to be continued and/or developed. This would include extension work, short courses and conferences, foreign programs, etc.

Organization - Definition of organization for administration.

In addition to the specific program areas of teaching, research, and public service and/or extension, there will be a need to provide for the development of objectives in the area of general university operation. The types of objectives that might fall into this category are listed as follows:

General Operation

Student Life Programs - Definition of student life programs including such items as student activities, student governments, sports and recreation, etc;

Systems and Procedures - Definition of objectives for administrative functions. This would include such items as computer systems for administration, centralized accounting systems, automated registration, library development, etc;

Student Housing - Definition of policies on provision of student housing;

Faculty-Staff - Objectives regarding faculty-staff qualifications and benefits to be provided.

The previous list of items for objective development is not intended to be an exhaustive list but is provided merely as a sample of the type of objectives that must be established. The objectives established by any given institution will be dependent upon the foresight, creative ability, and leadership of the administrative officials of that institution. The basic concept which must be grasped is the "management by objective" approach. The institutional objectives that are developed must provide the basic building blocks around which a "plan for accomplishment" can be developed.

PROCEDURE

All educational institutions have objectives which they are attempting to attain. In most cases, however, these objectives are not specifically enumerated for use by all decision-making units of the institution and there has been a lack of broad-based participation in their establishment. Some of the disadvantages of this condition are as follows:

(1) The objectives are not complete and fail to provide direction for all aspects of the institutional program;

(2) The objectives may exist in the minds of a few top level administrators and have not been fully conveyed to all levels of the institution;

(3) The lack of clearly specified objectives will result in inadequate plans of action for attaining the objectives.

There are numerous techniques that could be followed in establishing a well-defined set of institutional objectives. A step-by-step procedure which has been utilized is described as follows:

Establish Planning Responsibility - The chief administrator would select a person to assume the planning responsibilities of the institution under his direction. A detailed discussion of this responsibility will be presented later in this report.

Conduct Fact-Finding Study - A study should be organized and conducted to answer the questions of "Who Am I?" and "Where do I want to go?" in the greatest depth possible with reference to the university. Two basic sources of information which might be termed "Internal" and "External" should be utilized. The "Internal" information would be data developed by the faculty, staff, students, and administration of a university. The "External" information would provide data from local, state, and national sources. The consideration of educational needs at these levels would be of major importance. The external source would also provide an input from any master plan for education that might exist in the state. This input would be of vital importance in defining the role and scope of a given institution.

The fact-finding study should culminate in the orderly presentation of data and recommendations on the long-range development of the institution.

Establish Preliminary Objectives - The results of the fact-finding study should be utilized to develop specific objectives. This should probably be accomplished by a committee headed by the person who has been assigned the planning responsibility. The committee membership should provide a good cross-section of faculty, staff, and administration.

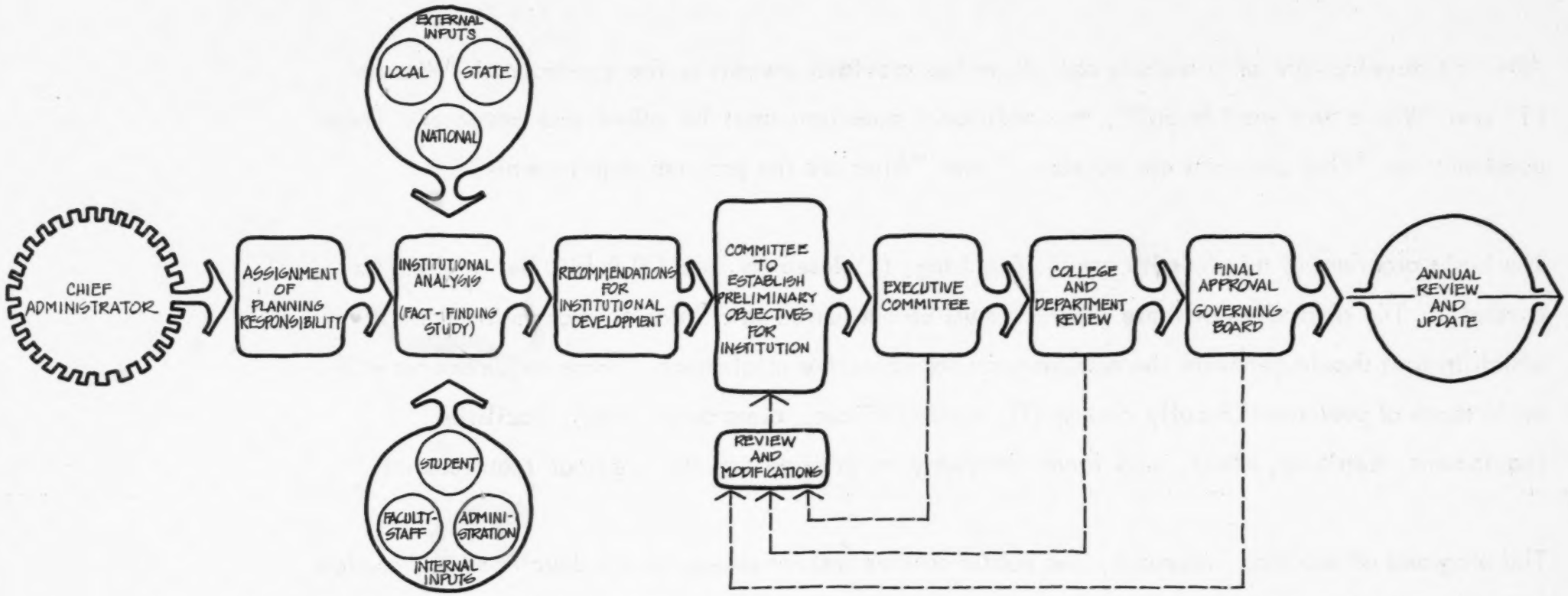
Executive Review - The preliminary draft of objectives would then be sent to an executive committee consisting of the president, vice-presidents and deans for review and modification.

College and Department Review - After review and modification by the executive committee, the draft of institutional objectives would be distributed to the college and department levels for review and modification. This step is vital as it permits involving and informing the entire organization of the institution.

Governing Body Review - After review and acceptance by the various organizational units of the institution, the statement of objectives would be sent to the governing board for their review, modifications, and final approval.

It will be noted here and emphasized later that the objectives as finally selected will be subjected to an annual review and will be modified as required to keep the institution responsive to change. The total suggested process of established objectives is illustrated in Figure 2.

FIGURE 2 · INSTITUTIONAL OBJECTIVES · FORMULATION PROCESS



PROGRAM PLANS AND REQUIREMENTS

After the development of university objectives has provided answers to the questions of "Who am I?" and "Where do I want to go?", two additional questions must be asked and answered. These questions are "What programs are necessary" and "What are the program requirements?"

The basic programs of a university are (1) Teaching, (2) Research, and (3) Public Service and/or Extension. The objectives of these programs must be converted to a "plan for accomplishment" which in turn should generate the requirements for objective attainment. These requirements will be in terms of personnel (faculty and staff), space (offices, classrooms, labs), facilities (equipment, furniture, etc.), and funds necessary to provide for the previous requirements.

The programs of teaching, research, and public service and/or extension are developed and implemented by the numerous organizational units in a university. Some of these units (academic departments, research institutes, extension service) will have primary responsibility for the programs while other units (library, physical plants, registrar, etc.), will provide a support function to aid the conduct of the programs. All of the units are vital to attaining the total objectives of the university and consume resources provided by the university.

It can logically be seen, therefore, that "plans for accomplishment" and "requirements" must flow from the various organizational units which will actually implement the university's programs. Thus, it is necessary to develop planning reports at basic organizational unit levels and have data from these reports flow up to and be combined at the college and university levels.

Planning reports would be required for all organizational units. These organizational units can be placed within two broad categories which are (I) Organizations for Program Implementation and (II) Organizations for Program Support. A brief listing of these respective categories is as follows:

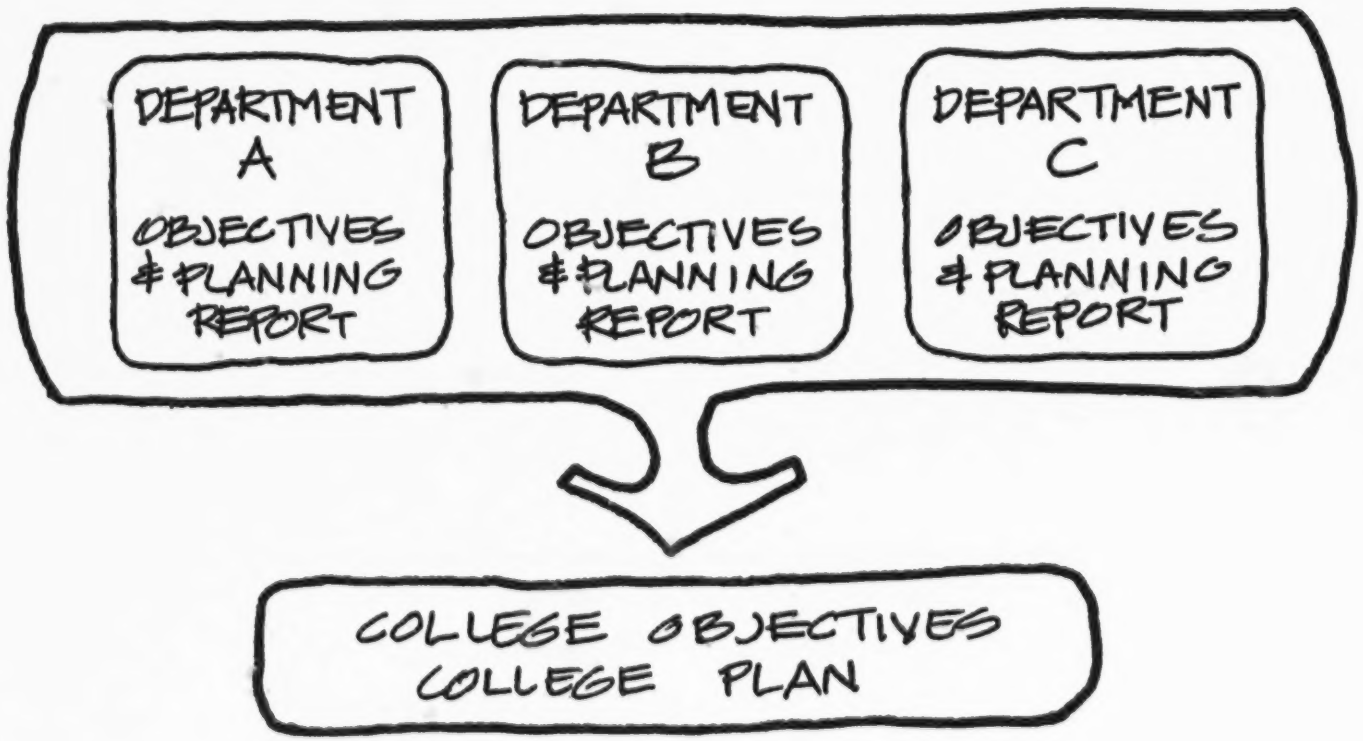
I. Organizations for Program Implementation
   - A. Academic Departments
   - B. Research Institutes
   - C. Public Service and/or Extension Units

II. Organizations for Program Support
   - A. Registrar
   - B. Library
   - C. Physical Plants
   - D. Administrative Offices
   - E. Other Support Units

In order to accumulate the desired data from each organizational unit on programs and requirements, it is necessary to develop a report format for the submission of these data. The next sections will discuss the basic content of planning reports that can be utilized for this purpose.

PLANNING REPORT·ACADEMIC DEPARTMENTS

The university objectives would provide basic guidance for developing the planning report for an academic department. The overall university objectives should be interpreted at the college level, and individual college and associated department objectives should be developed. Specific plans and requirements would be developed at the department level, and these data combined for all departments at the college level.



FORMAT

The information contained in the departmental planning report would furnish a basic source for planning. A report which would contain the following sections is suggested:

Organization Summary

This section would provide a concise presentation of the organizational structure, programs, and objectives of the organizational unit. The following information would be included:

Organizational Structure - Organization chart and descriptive material outlining the organization;

Programs - Programs in teaching, research, and public service and/or extension which are being conducted or planned for introduction;

Objectives - Major objectives of the organization.

Resource Inventory

This section would provide information on the resources available in the organization to conduct its programs. This inventory would include the following items.

Faculty-Staff Data - Vita sheets on each faculty and staff member;

Space Inventory - Detailed, room-by-room listing of all available space;

Equipment Inventory - Listing of all major pieces of equipment with details on the age, condition, etc., for each piece.

Past Activity

This section provides a historical record of past activities in teaching, research, and public service and/or extension. It can be utilized as a data base for future planning projections.

Activity Projections

This section provides projected data that will be basic to the planning process. These data are:

(1) Student Enrollment
(2) Research and Public Service and/or Extension
(3) Teaching Effort
(4) Staff Utilization

Resource Requirements

This section provides for the identification of resource requirements. The projected requirements include:

(1) Faculty-Staff Requirements
(2) Teaching Facility Space Requirements
(3) Non-Teaching Facility Space Requirements
(4) Capital Expenditure Requirements
(5) Operating Expense Requirements
(6) Total Budget Requirements

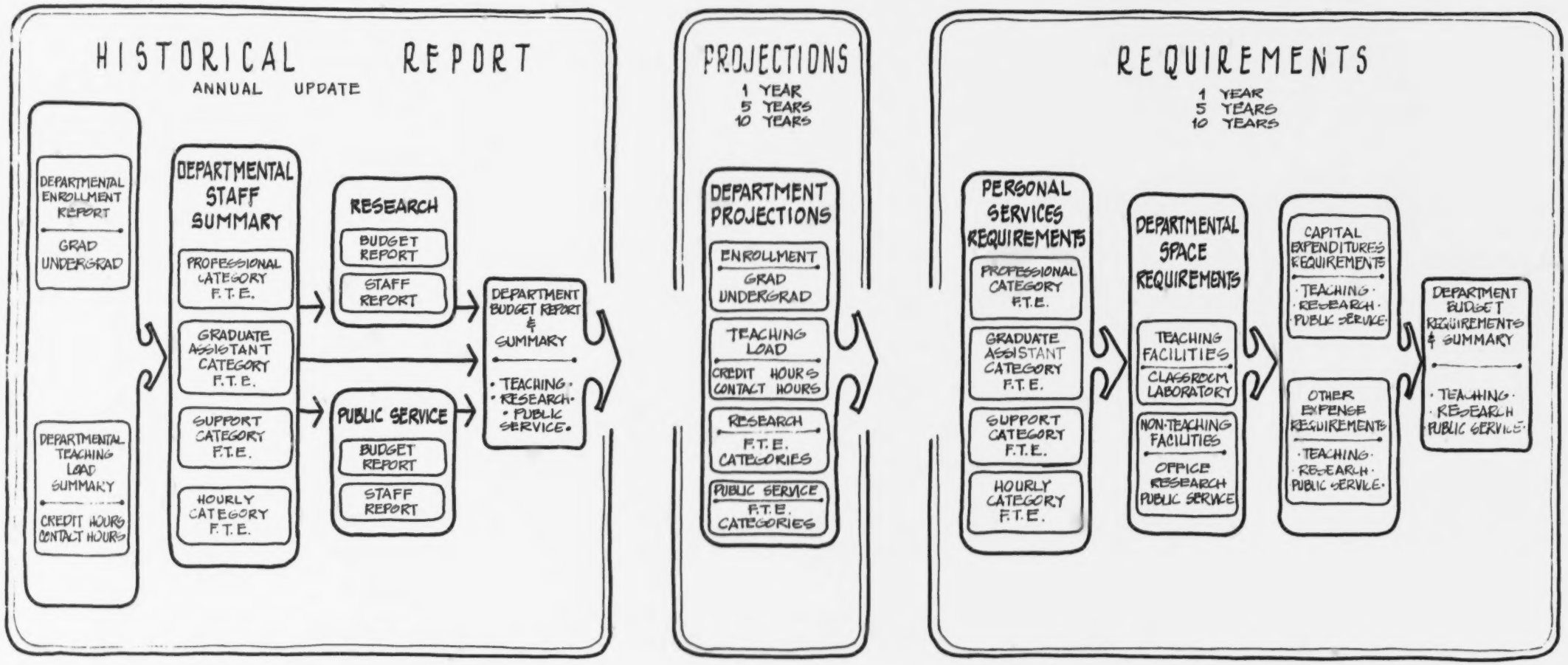
Department Plans

This section provides an outline of the specific plans of the department to meet selected objectives and to obtain the resource requirements of their programs. A graphic illustration of the process followed in developing the Academic Department Planning Report is shown in Figure 3. A detailed format of the planning process is presented in Volume II.

TECHNIQUE

The Academic Department Planning Reports would be developed as a second step of the Management Planning phase. They would utilize the overall objectives as a basic source of direction and would define individual department plans and program requirements. The departmental planning report will be discussed in detail in Volume II of the report on Planning Techniques. Figure 3 illustrates the data flow and content of a suggested Academic Department Planning Report.

FIGURE 3 · DEVELOPMENT PROCESS FOR ACADEMIC DEPARTMENT PLANNING REPORT



COLLEGE SUMMARY

The departmental planning reports will provide data for the development of a college summary report. This report will merge the various departmental reports into a total college plan and a list of program requirements.

Some iteration between the college level and the department level will, no doubt, be necessary to provide for the proper allocation of resources and the attainment of desired objectives. The college summary should also consider the plans and requirements of the college administrative office.

PLANNING REPORT · RESEARCH AND PUBLIC SERVICE AND/OR EXTENSION

In addition to the academic departments there may exist special organizations such as research institutes, extension units, and public service units which contribute directly to the programs of the university. Specific planning reports will also be needed for these organizational units.

The format of these reports will be similar to that of the academic departments but will require some special items. Basically these reports must also provide for the definition of specific plans and develop the requirements in terms of staff, space, facilities, and funds.

PLANNING REPORT·SUPPORT ORGANIZATIONS

While the academic and special departments will conduct the basic programs in teaching, research, and public service and/or extension, they are dependent upon a number of service organizations for support of their efforts. A partial listing of these organizations that serve all academic units are as follows:

Registrar	Purchasing Office	Fiscal Office
Library	Auxiliary Services	Personnel
Physical Plants	Information	Data Processing
	Student Services	

Planning for service organizations is dependent upon data relative to the programs of the various academic departments. Thus, it is necessary to develop the Academic Department Planning Reports prior to initiating planning work with the service organizations. Once the departmental planning reports are available, excellent data on requirements for support can be furnished to the service organizations to be used as a basis for their planning. Specific techniques for service organization planning will be presented in detail in Volume II.

Included in the planning for support or service organizations will be the requirements for various administrative offices (Deans, Vice-Presidents, etc.).

UNIVERSITY SUMMARY

After planning reports have been developed for the various academic departments, special departments, and service organizations, it will be necessary to prepare a summary of these plans and requirements to complete the Management and Program Planning phase. Figure 4 illustrates the elements of the Management and Program Planning phase and the sequence of development.

Also illustrated in Figure 4 is the output from the Management and Program Planning phase which is listed as follows:

(1) University Objectives;

(2) Plans for the Various Organizational Units of the University;

(3) Requirements of the Management Plans in Terms of Staff, Space, Facilities, and Funds.

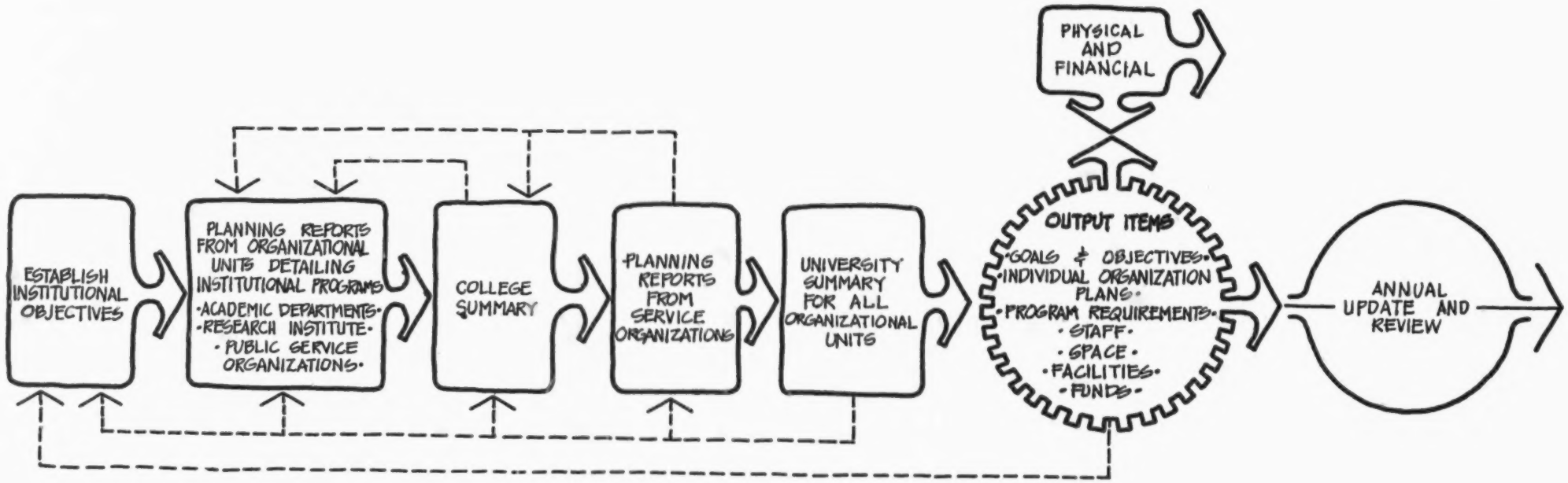
This output now becomes vital data for the Physical Plant and Financial phases to be discussed in the following sections of the report. Consequently, all planning flows from:

(1) Setting Desired Objectives;

(2) Developing Plans to Attain these Objectives; and

(3) Converting these Plans into Requirements for Faculty and Staff, Space, Facilities, and Funds.

FIGURE 4 · MANAGEMENT PLANNING PROCESS



PHYSICAL PLANT PLANNING

Physical Plant Planning is an essential component of the total planning process. The responsibilities of this planning procedure might be best described as the translation of abstractions and singularly dimensional goals and objectives into the second, third, and fourth dimensions--physical forms over time. Although the emphasis in past institutional planning efforts has usually been centered on this phase, it was found that there was a great need for logical, systematic procedures for the development of plans for physical plants. This research and development effort has concentrated on the development of systematic procedures which could be integrated into the total planning process.

For purposes of organization and development of physical plant planning procedures and criteria, it was desirable to consider this phase in terms of the following elements:

(1) Facilities Planning
(2) Traffic, Parking, and Circulation Planning
(3) Utilities Planning
(4) Land Use Planning

Each of the above elements represents a vital part of the Physical Plant Planning process and will be discussed in the following material.

Effective physical planning is by no means an independent process--it is dependent upon interactions and inputs from the other phases of Management and Program Planning and Financial Planning. This translation process encompasses a broad spectrum of considerations, and the object of the following material is to present a systematic guideline outlining and organizing these complex considerations (which will be discussed in depth in Volumes III, IV, and V).

FACILITIES PLANNING

The major impact of physical plant changes results from the construction of buildings. These buildings should in turn result from the translation of objectives into specific plans and plans into physical requirements.

Two basic types of building construction which must be considered are:

(1) Academic Facilities and

(2) Residential Housing.

ACADEMIC FACILITIES

The planning reports which will be developed in the management phase of the total planning process will indicate the total square foot requirements for academic space of different types. The techniques for obtaining this data will be discussed in detail in Volume IV, but, basically, the study must develop needs for teaching facilities (classrooms and laboratories) from a projection of the teaching program in terms of students to be enrolled and student contact hours generated. There is also a need for data on requirements for non-teaching facilities space (offices, research labs, work space, etc.) to be obtained from a projection of staff to be housed and requirements in research labs, public service and/or extension programs, and administrative units.

RESIDENTIAL HOUSING

In addition to academic space, building construction may also be required to furnish residential space for students and, in some cases, for faculty and staff. Thus, studies which will identify and project the requirements for future residential housing are needed.

In the case of student housing it is necessary to develop characteristics of the student body relative to housing needs. This would include such data as future enrollments, percent male and female, and percent married. Also the policies of the institution relative to student housing must be examined and some decisions made relative to future housing policies.

While most institutions will not build faculty and staff housing, it should be a major concern that adequate housing is available. Here is a further example of the need for a cooperative effort between the university and the surrounding community. The university has a responsibility to develop adequate data on its needs for faculty and staff housing and to make this need known to the community. If the housing resources of the community are not adequate, then the university must urge the community leaders to meet this need, or, as an alternative, the university must make provisions of its own.

REQUIREMENTS

The results of the studies of academic facilities and residential housing should provide basic data for future requirements in these two categories. The academic facilities requirements would be defined in terms of square feet of classrooms, teaching labs, offices, research labs, and work areas. The residential housing requirements would be developed in terms of dormitory rooms, apartments, and other types of housing units.

ANALYSIS OF EXISTING BUILDINGS

In addition to developing total space requirements an institution must make a thorough analysis of its existing space. This analysis would consist of completing three basic studies which are listed as follows:

(1) Inventory Study

(2) Quality Study and

(3) Utilization Study

Inventory Study - A university must conduct a thorough inventory of its existing buildings. This inventory should provide data on a building-by-building and room-by-room basis. The inventory would indicate the area and use of every room.

Quality Study - A second study which must be conducted relative to existing buildings is an analysis of the quality of each building. Such a study would consider a ten-year planning period and seek to place every building of the university in one of the following categories for this planning period:

(1) Satisfactory - No modifications required during planning period;

(2) Satisfactory - Minor modifications required;

(3) Unsatisfactory - Major alterations required;

(4) Unsatisfactory - Should be demolished.

Utilization Study - A third and vital study is a utilization study to determine if maximum utilization is being made of existing space. This study would include teaching facilities, non-teaching facilities (offices, research labs, etc.), and residential space. This study would assure that maximum benefit is being obtained from existing space.

A detailed presentation of techniques relative to the three studies indicated above is presented in Volume IV.

CONSTRUCTION PLAN

After completion of the previously discussed studies the desired data is available from which to formulate a construction plan. The total space requirements have been forecasted, and a thorough analysis of existing space has been conducted. The total space requirement, less existing space, will indicate the basic space to be provided in the construction program.

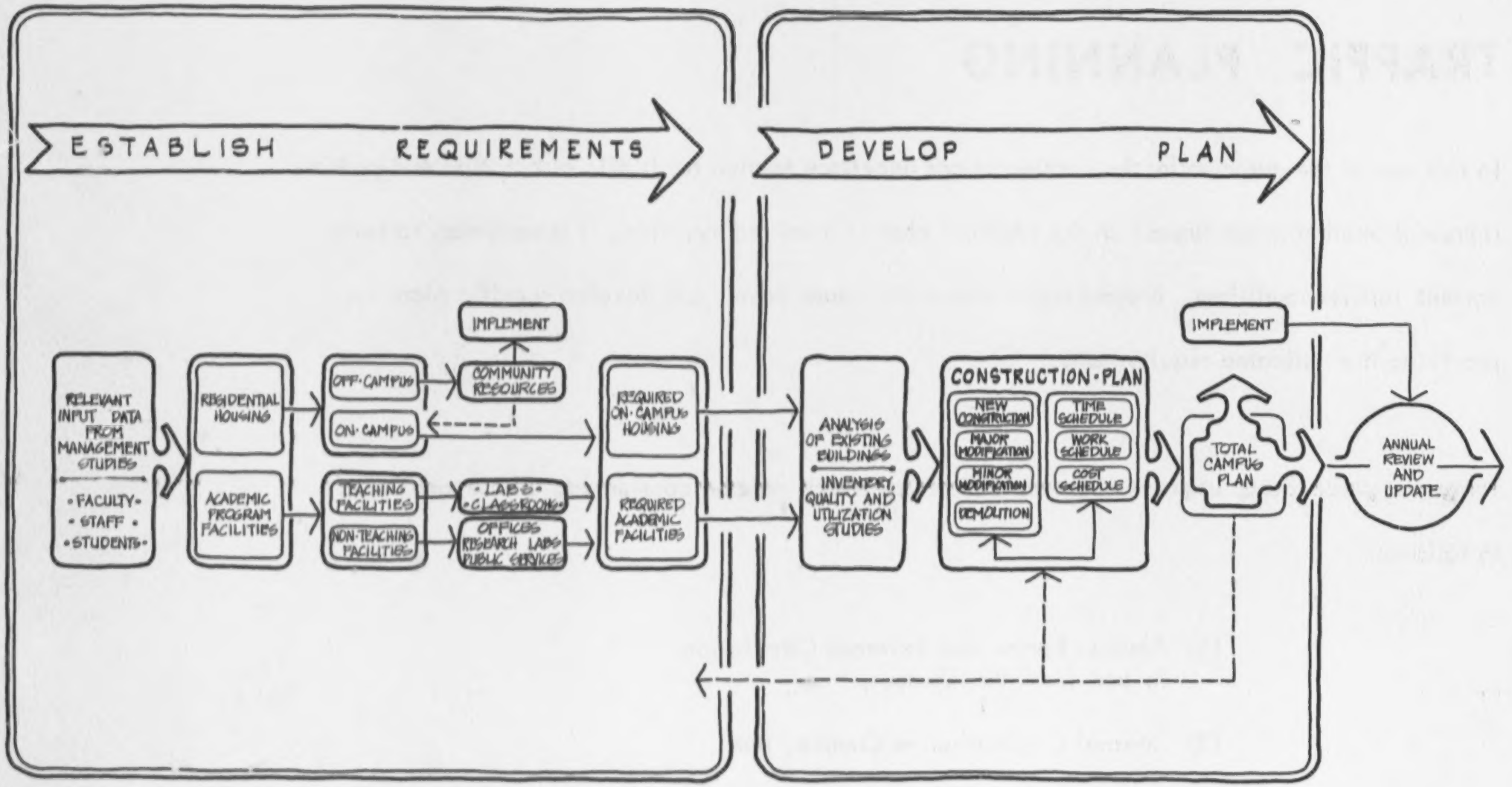
For a new university the construction plan would consist of new buildings. For an older university the plan for providing the total required space would possibly include all of the following:

(1) Minor Modifications to Existing Buildings;
(2) Major Modifications to Existing Buildings;
(3) Improved Utilization of Existing Space;
(4) New Construction.

It is important that the construction plan reflect the work, time and cost of both modifications and new construction.

A graphical summary of the work to be completed in developing a construction plan is illustrated on the opposite page in Figure 5. A detailed discussion of the study techniques involved is presented in Volume IV.

FIGURE 5 · FACILITIES PLANNING PROCESS



TRAFFIC PLANNING

In this age of the automobile, the considerations necessary to plan for traffic circulation and parking represent another major impact on the physical plan of a university. Thus, it is necessary to study present traffic conditions, project requirements for future years, and develop specific plans for providing the indicated requirements.

There are three basic elements of traffic planning which must be considered. These are listed as follows:

(1) Access, Egress and External Circulation to and from the Campus;

(2) Internal Circulation on Campus, and

(3) Parking on Campus.

The basic studies associated with each of these elements will be discussed briefly here and presented in detail in Volume III.

ACCESS, EGRESS AND EXTERNAL CIRCULATION

It will be necessary to study the characteristics and travel patterns of the traffic flow moving to and from the campus. Basically, the following information is desired:

(1) Street System Inventory
   a. Classification
   b. Capacity analysis
(2) Traffic Characteristics
   a. Origin and destination of trips
   b. Type of movement
   c. Peak and off peak movement
(3) Traffic Assignment
   a. Present
   b. Future projection

The external street system should be able to handle the traffic demand imposed upon it, both present and future. Since the transportation system affects the location of future development, a thorough inventory of the street system will provide the data necessary to make decisions on future improvements, as well as point out existing trouble spots.

INTERNAL CIRCULATION

Next, it will be necessary to consider the movement of traffic on campus. This may be pedestrian only or a combination of vehicular traffic and pedestrian. Studies of this element must consider the characteristics of the internal traffic and the ability or inability of the street system to accommodate vehicular movement including service vehicles.

The characteristic studies should examine the movement of staff and students on campus and the movement of goods and service and emergency vehicles.

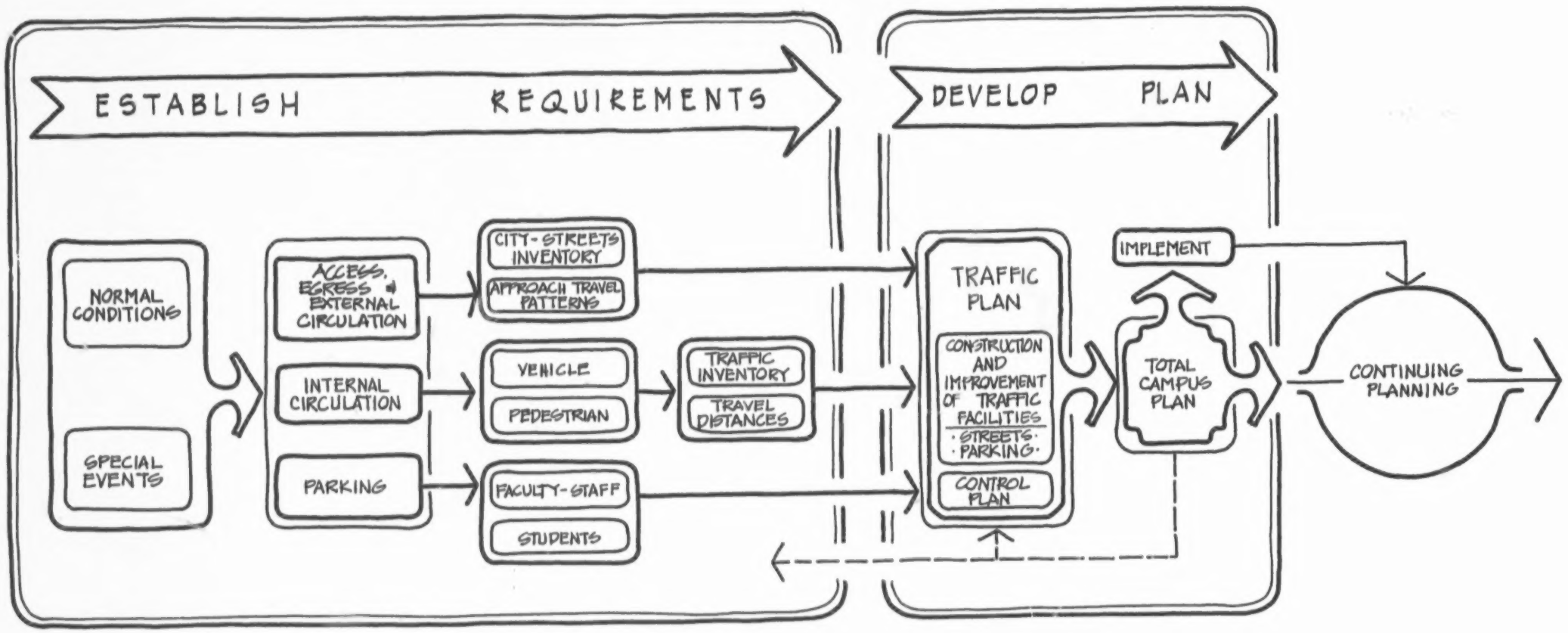
PARKING

In addition to moving traffic to and from the campus, consideration must also be given to parking vehicles. The demand for parking for both students and staff must be identified as a first step. Second, an inventory of existing parking facilities must be conducted to determine the existing capacity to accommodate parked vehicles. Also pertinent to this study is the type of enforcement and control being employed.

After the basic studies on Access, Egress, and External Circulation, Internal Circulation, and Parking have been completed, it is then necessary to project future requirements considering desired policy changes and future conditions and demands. With these projections, it will then be possible to identify future requirements in terms of new or improved streets, parking facilities, and traffic control measures.

A graphic summary of the traffic planning process is illustrated in Figure 6. A detailed discussion of the study techniques is presented in Volume III.

FIGURE 6 · TRAFFIC PLANNING PROCESS



UTILITIES PLANNING

Utilities planning must be coordinated with the data developed in those sections on the curriculum, the relative proportion and type of research and educational facilities, present or initial enrollment in each department or division of the university, and projected future enrollment. All of these data from the Management Planning phase which develops the overall picture as to the type of campus to be served will help establish the utilities requirements of a campus.

The development of the utilities systems is influenced by the physical arrangement of campus facilities. A compact campus on which expansion is more vertical than horizontal would require a different utilities concept from one consisting of dispersed, low buildings.

Since the utilities systems serving the campus represent approximately 15% of the initial construction cost of campus facilities, the relative costs of utilities systems should influence the planning process in the determination of the physical arrangement of the campus facilities. The relative costs of various utilities systems and the effect of these costs on the spacing of buildings may influence the final determination of building spacing and size.

This emphasizes the need for the continual reference and coordination of utilities planning with other aspects of the planning process during the preparation of any master plan for development of a campus. One would not design a campus based strictly on the economies to be effected in the utilities systems but should consider the economic aspects of the overall plan as well as the aesthetics and educational requirements.

The utilities system for a campus can be considered in the following three categories:

(1) Energy utilities

(2) Service utilities

(3) Communications utilities.

The energy utilities have the greatest effect on the physical arrangement of a campus. These utilities include services for space conditioning, electric service for power and lights, and for steam. Service utilities would include water, sewerage, drainage, and compressed air. Their cost will vary with the physical arrangement of the campus but are generally not significant in the determination of the cost of the total campus plan.

Communications utilities include telephone, clock and signal, and data transmission. The cost of these communications and their details of design is affected more by the type and size of the university than by the physical arrangement of the facilities.

The relative influence and effect of the determination and design of these three categories of utilities systems will be discussed further in the following material.

ENERGY UTILITIES

One of the major utilities considerations for a modern campus deals with the conditioning of the space within the campus buildings. This will generally consist of heating or cooling on a seasonal basis although on most campuses cooling will be required year around for internal rooms and large assembly rooms. Close control of space temperature and humidity conditions may be required in areas in which research projects are being conducted or for storage of critical materials. Space conditioning is usually accomplished by use of air distribution systems from fan and coil type units

or some equal system. These individual building units must be supplied with sources of cooling and heating either from equipment located within that building or remotely located in a central utilities plant and distributed to the individual buildings by one of several means. Frequently, this consists of utilizing heated and chilled water from a central utilities plant. One further consideration is the method of piping the water (direct burial, utility tunnel, or combination). In some cases, the piping may be run under the roof of above-ground passageways. The cost of distributing these utilities from the central plant to the individual buildings and the physical location of the campus buildings will influence the decision on whether to use a central plant or individual building water heating and chilling systems.

The central plant has the advantages of lower maintenance and operating costs, reduced installed capacity due to diversity of load, and reduced operating staff. These advantages and their relative costs must be properly evaluated along with the cost of the distribution system for these utilities as opposed to individual building systems requiring only that the source of energy for the heating and chilling be distributed. This decision is further influenced by the number of buildings being constructed and existing campus facilities. This would include consideration of removal of existing individual systems and reconnection to a central system immediately or at future dates.

Equally important and costly is the provision of electric power and lights for the campus facilities. Again, consideration must be given to individual building systems versus a central utilities plant, but, insofar as power generation is concerned, the central plant is almost always the most economical. Consideration must be given to generation of electric power compared to purchase from a local utility company. The use of natural gas or other fuels must be considered as energy sources for power generation in a central plant or alternately as a heat energy source at individual buildings.

Regardless of the source of the electric power, it must be distributed to the buildings of the campus to serve the lighting systems within the buildings as well as area lighting and power outlets. Distribution may be at a relatively high voltage such as 12,500 volts with transformation to using voltage in each individual building. Alternately, transformers may be installed in electrical sub-stations in a location to serve several buildings where the distance between the sub-stations and the buildings permits distribution at relatively low voltage (such as 2,400 volts).

Distribution costs will be affected by aesthetic requirements. Lines may be installed on pole line structures, buried in duct banks, or installed in utility tunnels. Interconnecting tunnels may be justified for electrical distribution when included with other utility systems.

Other energy type utilities may be required such as steam at various pressures for laundries, mess halls, and special research facilities. Steam may be used as the energy source for water chilling equipment in individual buildings. Distribution of steam and return of condensate would be similar to that of heating and chilling water with piping either in tunnels or above ground on racks or under passageway roofs.

SERVICE UTILITIES

Service utilities include water supply, sewage disposal, area drainage, and, occasionally, compressed air distributed to buildings or areas. Usually, the water for the campus is obtained from a local water supply company or municipal system. Occasionally, the campus location may require the development of a well field or a surface supply such as a river or lake. The choice of the source will usually be made on the basis of the cost of water. If the water varies considerably in quality, treating costs should be added to the initial cost of the water. For normal consumption of water for drinking purposes and sanitary facilities, the minimum treating requirement is usually chlorination for health protection. In some areas, it may be necessary to soften the water or to deaerate it to increase its usability and to reduce the deleterious effect on equipment. The cost of distributing the water underground to the buildings on the existing or new campuses varies with distance between buildings, but the quantity of water consumed is small and the cost of water piping is not a significant figure.

Variations in the cost of sewage collection and disposal systems from the campus buildings would not be a major factor in the decision on location of the buildings. The treatment of the sewage will probably be at a central collection point, and the type of treatment will be selected depending upon the quantities involved, provisions for future expansion, and any special treatment required due to unusual waste disposal requirements from the campus facilities. Location of a treatment plant will probably be as remote as possible from other facilities on campus and in such a location as not to interfere with surrounding land utilization.

Surface drainage is almost completely independent of any other considerations on the campus except streets and parking lots. Its cost is influenced mostly by topography of the campus site and

climatic conditions including annual rainfall and maximum rates of rainfall or other forms of precipitation. The choice usually resolves itself to one of complete surface runoff or an underground storm sewer system with area drains strategically located or a combination of both. Underground drainage systems are usually installed prior to and in connection with road and parking lot improvement as these facilities tend to accelerate runoff and flooding and to increase the need for subsurface drainage to supplement surface runoff.

COMMUNICATIONS

Communications systems on a campus do not normally influence greatly the arrangement of physical facilities for the campus as most major items of equipment are in the individual buildings, and the interconnecting wiring is relatively inexpensive. The telephone communication system is normally installed by the local telephone company, including the interconnection with their system and the campus system, the campus switchboard, the individual telephone sets and all interconnecting wiring. The internal campus system from the switchboard to the individual sets and including the individual sets can be campus owned and installed and operated but this is generally not done.

Clock and signal systems are available for campus use in several types including service provided from outside sources. There is at least one such outside source which provides for automatic reset of campus clocks. Other systems are available which would be campus owned and would provide automatic reset of time and include signal systems for classroom bells, fire alarms, etc. Some of these systems require independent system interconnecting wiring, and others are superimposed on the electrical distribution system. In either case, the system costs are practically independent of the physical arrangement of campus buildings and have little affect on determination of overall campus planning.

(2)

Other types of communication systems are available and may occasionally be installed including radio and pneumatic tube. These generally are limited to a special application and are not used for interconnection of all buildings.

Planning of any new campus or expansion of existing campuses should also include consideration of the utilizarion of a data reclaim system. Recent developments have produced many new methods of data storage, reclaim, and transmission. Computers are used to analyze attendance of peak demands on classrooms, cafeterias, and assembly rooms and to store multitudes of information, including library information which can be made available electronically to all campus facilities and departments of instruction. Even more elaborate systems are available to provide data to the individual student in his dormitory room by simply dialing a coded number for the data and information desired. Closed circuit television systems between buildings are used for classroom instruction, observation, monitoring, and security on many campuses and can be tied in with data reclaim transmission where desired. Closed-circuit television is being expanded to provide service from campus to campus and city to campus. Some universities are making available television reruns of lectures for students who missed the original lecture or did not understand it completely.

SUMMARY OF CONSIDERATIONS

To summarize, the energy utilities exercise the greatest cost influence on physical plant planning and must be considered concurrently with other factors during the management decisions on campus location, land utilization, and budgetary requirements. Strategic locations of central plant facilities and proper planning of initial and subsequent campus building locations can result in the lowest utilities systems cost initially and continued low cost with expansion through good

planning. Poor initial planning may produce expansion bottlenecks and exorbitant utilities costs due to the necessity of revising existing systems instead of merely enlarging them.

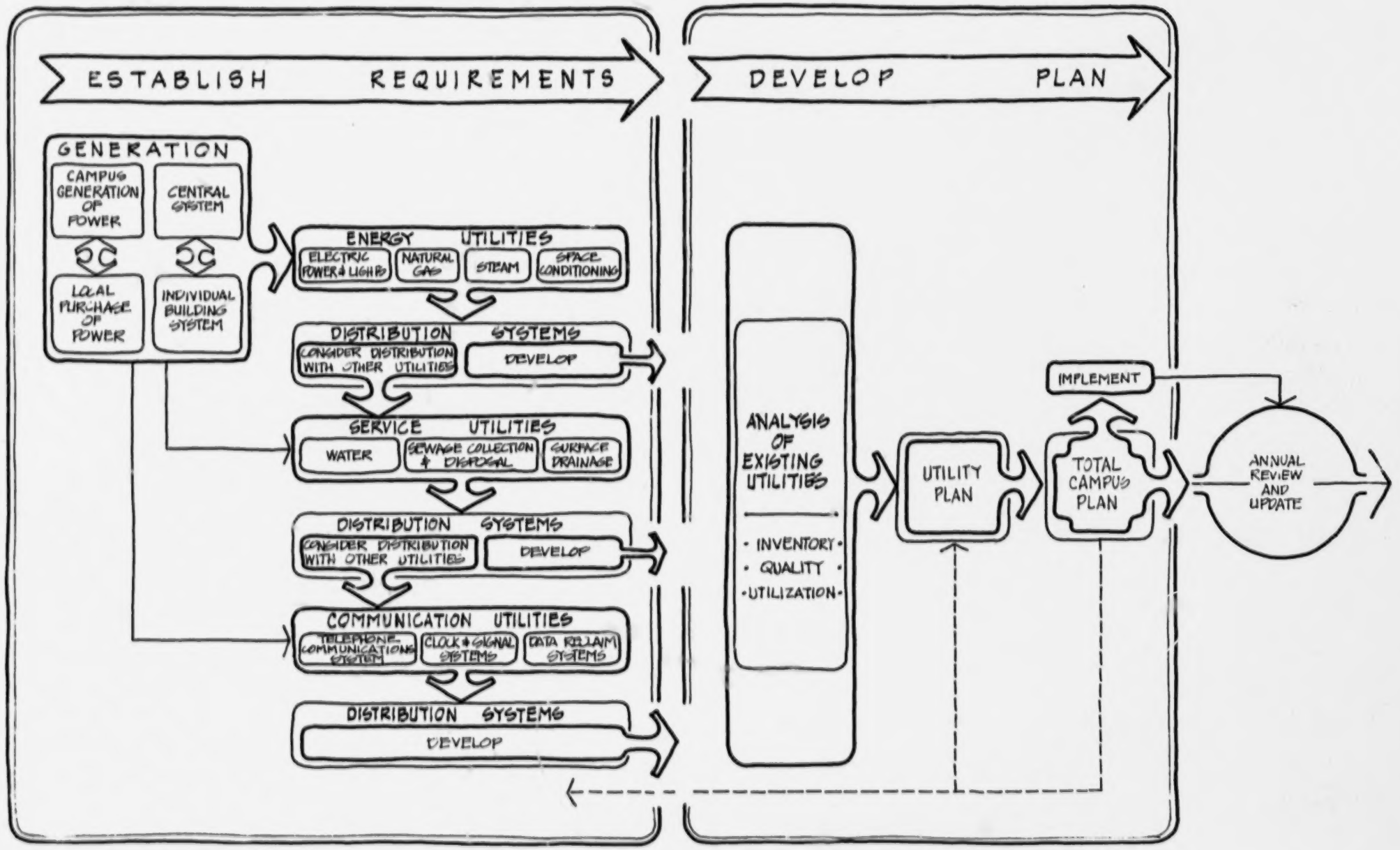
Campuses located in large municipalities will generally find relatively low cost water and power supplies available to them and probably sewage and surface drainage disposal through existing local systems. Campuses located in remote areas may be faced with providing their own water supply and sewage disposal plants and may find the costs of electric power from available sources sufficiently high as to require generation of power within the campus utilities system.

The utilities systems planning of any new campus or enlargement of any existing campus must always take into consideration future growth and at least provide space for installation of future equipment and where practical sufficiently large distribution mains, tunnels, central plant buildings, etc., to require a minimum of revisions or additions in the future. This may result in higher initial costs but considerably lower ultimate costs for the campus utility systems. These advantages must, of course, be weighed against budgetary limitations and be commensurate with the time of future expansions.

It is of prime importance that the planning of campus utilities be coordinated with the overall planning. A coordinated effort will produce the lowest costs and best coordinated and planned systems. The best systems will provide the least interference with the other operations of the campus and contribute to the overall appearance and image as a college campus.

Figure 7 presents a graphic summary of the basic studies and the general decision-making process relative to utility planning. A detailed presentation of utility planning is presented in Volume V.

FIGURE 7 · UTILITIES PLANNING PROCESS



The outline indicated below illustrates the basic considerations that will be discussed in the following sections:

I. Basic Determinants

- A. Management goals of the institution
- B. Financial capabilities
- C. Physical characteristics

II. Design Factors

- A. Tangible components
  1. Academic program
  2. Common uses
  3. Support functions
  4. Circulation
  5. Building density
- B. Intagible components
  1. Flexibility (convertibility)
  2. Expansion
  3. Social interactions
  4. Aesthetics
  5. Institutional personality

III. Land Use Planning Concepts

- A. Concentric
- B. Sector
- C. Lineal
- D. Cluster (satellite)
- E. Random

BASIC DETERMINANTS

The basic determinants are, as the term implies, the foundation of the overall, comprehensive physical planning process. They are the factors which will, individually and collectively, greatly influence the decision-making process that is involved in ultimately selecting a particular planning concept.

The basic determinants are input factors that have resulted from the management and financial phases and specific physical plant studies. These factors are concerned with management goals of the institution, financial capabilities of the institution, and physical characteristics of the campus. The ideal set of determinants are rarely completed, and effective planning must recognize the input needs and be directed toward securing this information. The determinants should not, however, be regarded as inflexible, fixed factors. It may be indicated in subsequent stages of planning that there are inconsistencies, and some policies and objectives may require change or modification. This illustrates the effect of feedback which is the backbone of effective planning.

Management Goals of the Institution

Management goals express the basic intentions of the Institution relating to the extent and character of the present and future educational objectives. They include the academic plan which indicates the curricular emphasis, policies relating to research orientation and extension services, administrative policy, student life programs, etc. The goals are especially significant because they "can convey prime distinctions, account for speculative thought, and indicate the impact of both real and possible conditions on physical planning".[2] It is a thorough identification and interpretation of these goals that establishes the framework of the physical plan.

Financial Capabilities of the Institution

The financial determinant is an indicator of the amount of money, currently and in the future, that is or will be available for necessary capital improvements. Financial capabilities may, in the final analysis, be one of the strongest determinants influencing the ultimate form of the campus. Such considerations may also necessitate some modification of the goals of the institution when each factor is evaluated with respect to one another.

Physical Characteristics

The physical determinants are those factors relating to the physical structure of the campus. These considerations present a significant impact upon the physical plan when one is expanding an existing campus. Under such circumstances, the characteristics of the site, the location, and the existing facilities will have a profound effect upon the solution. Physical factors relative to either a new or an existing campus would include recognition of the facility needs as a result of the management goals.

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[2] *Campus Planning*, Richard P. Dober, Reinhold Publishing Corp., 1963

DESIGN FACTORS

In addition to the basic determinants, there is another set of considerations that influences the configuration of the physical plan. These considerations are identified as the Design Factors and are divided into Tangible and Intangible components. It is essential that they be analyzed, evaluated, and resolved in light of the basic determinants prior to a definite commitment to a particular land use plan. These factors are essentially the separate components of a campus plan that must first be recognized individually and then subsequently molded into a comprehensive plan.

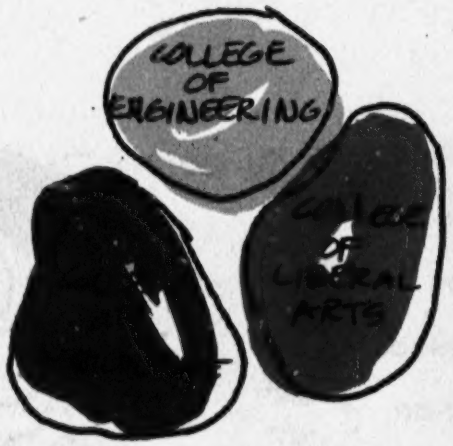
Tangible Components

The tangible components of the Design Factors are divided into several categories and sub-categories which are as follows:

FUNCTION ORIENTED

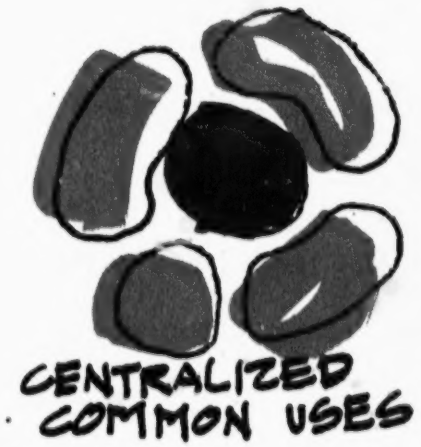
Academic Programs are structured about essentially one of two basic orientations which are organization according to function or organization according to discipline.

In the case of the academic program that is structured around a functional orientation, facilities are grouped according to their specific uses. Facilities such as laboratories are grouped together in one area and classrooms are grouped in another area. A functional orientation provides a greater degree of personal contact and interaction between different disciplines. The extent of this personal interaction, of course, depends upon the detailed design.

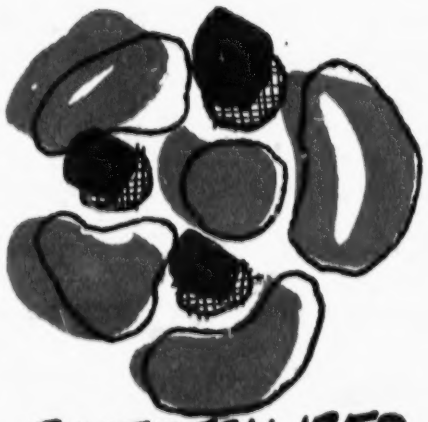


DISCIPLINE ORIENTED

A discipline oriented plan groups facilities according to the colleges they serve. For example, all classrooms, laboratories, faculty offices, etc., serving a College of Liberal Arts would be located in a single area. This kind of arrangement also provides a good deal of student-to-student and student-to-faculty exposure. However, this exposure is limited primarily to individuals and groups from the same discipline.

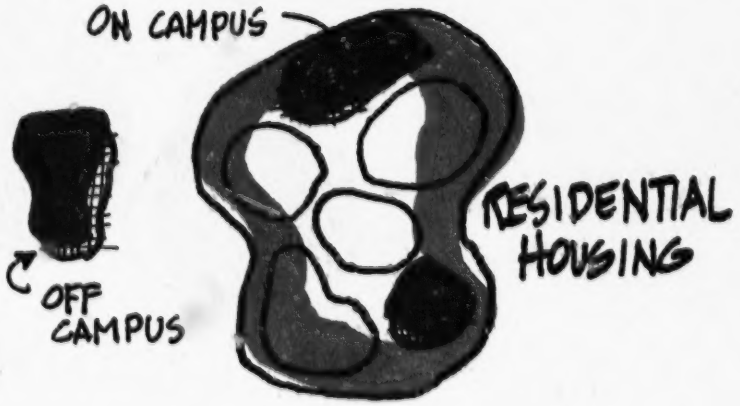


Common Uses on a campus refer to those facilities which are frequently used by all persons regardless of their classification. Common uses which fall into this category include such facilities as libraries, student unions, book stores, dining halls, and, in some cases, faculty offices and administrative offices. These common use areas may be either centralized or decentralized in the physical layout of the campus. The decision is largely a matter of scale and consideration of educational objectives. It is generally agreed by both administrators and planners that it is most advantageous to centralize or group together common uses from the standpoint of economy and accessibility. Centralization, however, does not necessarily mean that this grouping of facilities must be located at or near the center of the campus. These uses may be located in a section of the campus somewhat removed from the center and still be centralized.

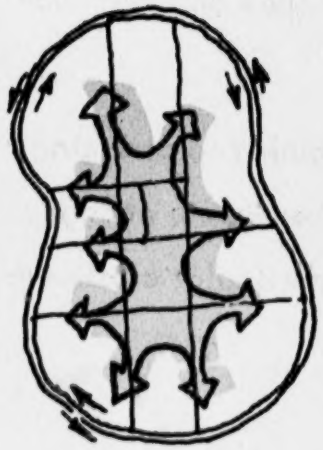


The matter of decentralized common uses requires relatively little explanation insofar as it implies that separate facilities of high use may be separated and scattered throughout the campus.

Support Functions refers to such facilities as housing, utility services, recreation areas, and open space. These are the elements of the campus plan which can exert a significant influence on the selection of a land use plan and on policy decisions but which are often treated rather lightly or taken for granted. With respect to housing, for example, decisions must be made as to whether an institution will be fully or partially resident or totally non-resident. Any decision on this matter will certainly affect management and financial policy.



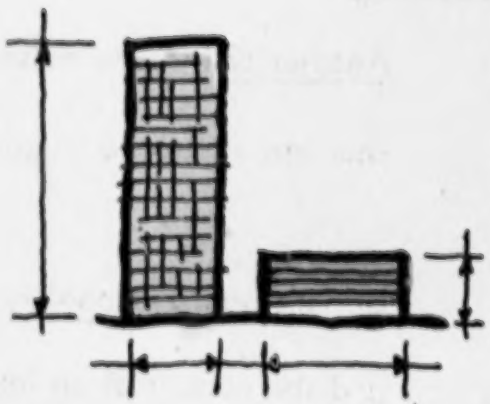
AUTOMOBILE ORIENTED



PEDESTRIAN ORIENTED

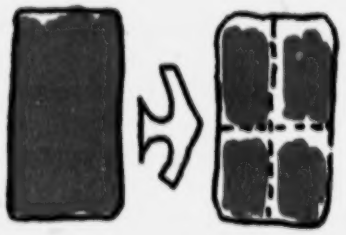
Circulation refers to the movement of the faculty, staff, visitors, and student body in, through, and around the campus. There are essentially three alternative decisions that can be made with respect to the circulation system. A campus may be oriented totally toward the automobile as a mode of transportation, totally toward pedestrian movement, or there may be a combination of the two modes with emphasis upon a particular orientation. Generally, the combined orientation is the one that prevails. The selection of a circulation system may be one of the most vital decisions in the planning process. A commitment to an automobile orientation, for example, requires that more land area be used resulting in wide spacing of buildings. A pedestrian orientation, on the other hand, allows a more compact arrangement of facilities.

Building Density refers to that aspect of the campus plan which deals with such components as the coverage, bulk, and horizontality and/or verticality of the buildings on the campus. Policy decisions must be made with respect to the direction in which a campus will grow. Selection of either a vertical or horizontal theme will necessarily have an effect on the coverage and bulk or spacing of buildings, which will in turn affect the ultimate plan.



Intangible Components

The intangible components do not assume a particular form nor do they directly occupy space (as do the tangible components), but they are highly significant because they do exert substantial influence upon the configuration of a form or space.



Flexibility is the capability of responding or conforming to changing or new situations -- or simply, the ability to accommodate change. This factor must be applied at all scales -- from a particular classroom to the total campus structure.

Expansion, as differentiated from flexibility, is the ability to accommodate growth. This factor also requires consideration and application at all scales.

Social Interactions imply the need for consideration of the total spectrum of interactions that will occur, as well as will be encouraged to occur, on the campus. This would include student(s) to student(s), student(s) to faculty, university to community, etc.

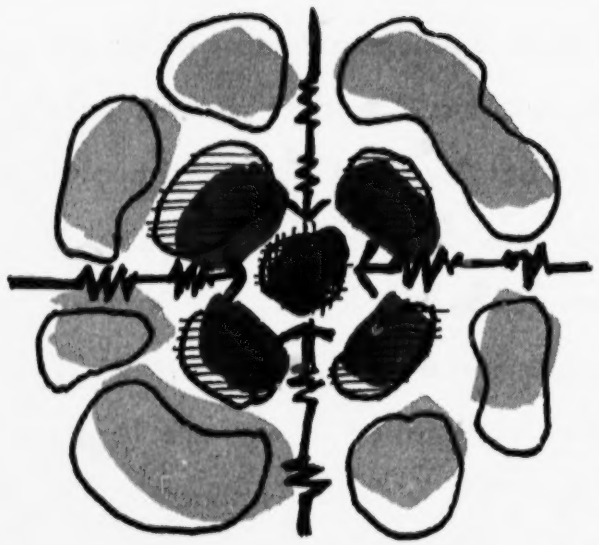
Aesthetics include those considerations relative to the beauty, attractiveness, and meaning that are expressed in particular facilities as well as the total environment.

Institutional Personality relates to the recognition and response to the influence of traditions and the pursuit of an image that will affect many decisions.

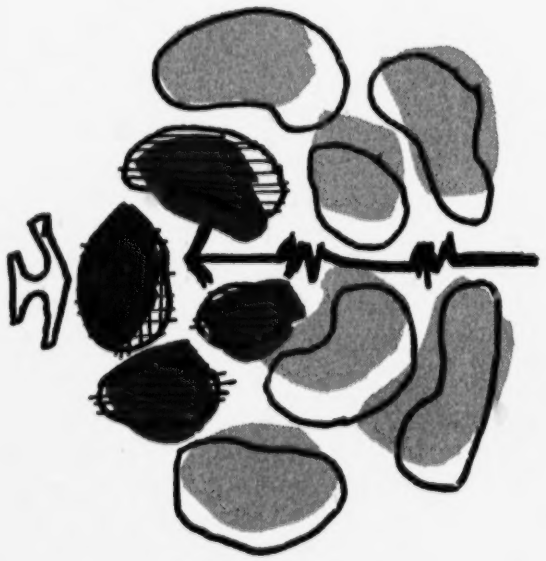
LAND USE PLANNING CONCEPTS

The previous discussion dealt with those considerations -- basic determinants and design factors -- which are essential to the ultimate development of a land use concept. The following material focuses upon a generalized identification and definition of the basic land use concepts which are to be applied as tools of reference. As a matter of clarification, the term "concept" in this context is considered to be synonomous with the word "form". The actual "concept" is the form-giving idea which is derived from careful analysis and evaluation of the previous sections. The material in this section is simply a synthesis of the many concepts that have been developed. The implications involved in the formulation of a land use concept--relative to the specific institution--are too complex to even suggest that these concepts should be directly applied. There are innumerable variations and combinations of each basic approach, and it is within this spectrum of solutions that an ultimate land use plan will be conceived. (This entire process is discussed in considerable detail in Volume III.)

Concentric Concept

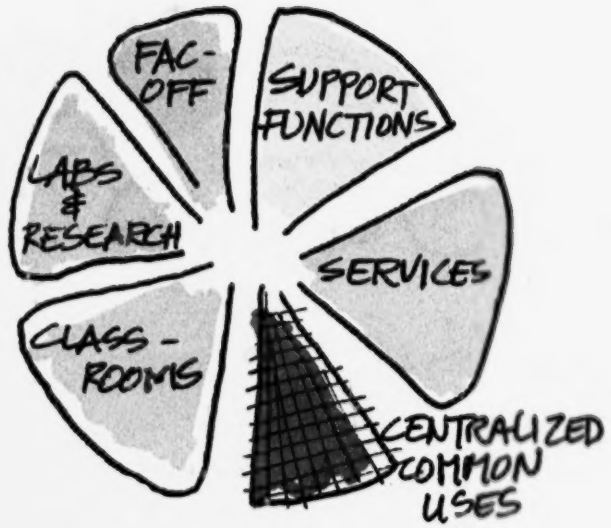


Campus land uses guided by this concept would place the highest concentration of common uses and interaction in a centralized location on the campus. This area would then be encircled by the next highest use categories, and these, in turn, would be encircled by those facilities which are less frequently used, etc. This concept and its hierarchy of rings can be easily applied to either a function or discipline orientation.

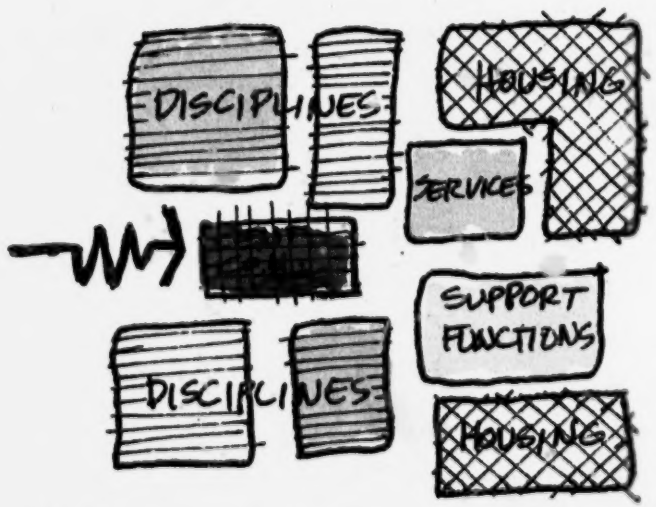


With respect to an existing campus, facilities may be strewn in a random location. It is conceivable that facility utilization may be reallocated to achieve this concept with relatively little change to the existing physical structure. This may result in high initial expenditures at the time of conversion to this concept, but, viewing this from a long-range perspective, it may be the least costly course to pursue.

Sector Concept



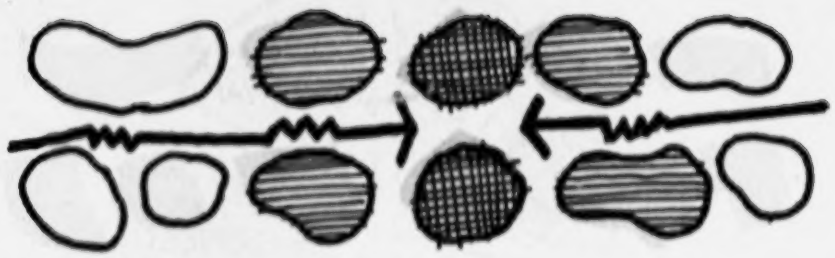
FUNCTION-ORIENTED SECTOR



DISCIPLINE-ORIENTED SECTOR

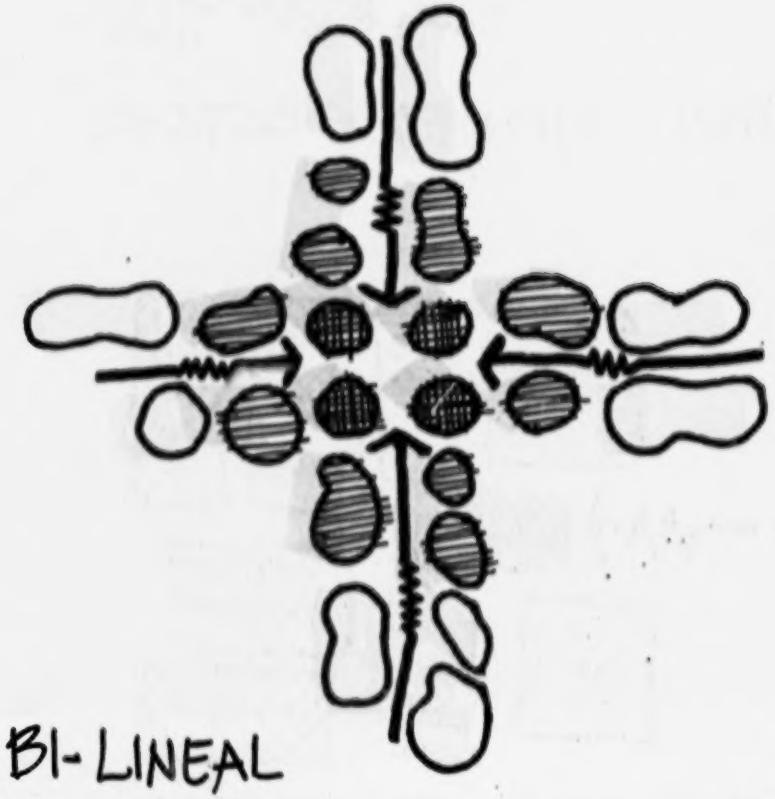
This approach divides the major facilities of the campus into sectors or particular districts. The sectors are usually organized with reference to a function or discipline orientation. Many of the existing campuses illustrate, to some degree, this approach -- and they are most frequently discipline oriented. This is generally due to the growth of these campuses "over time" accompanied by the addition of new programs.

Lineal Concept

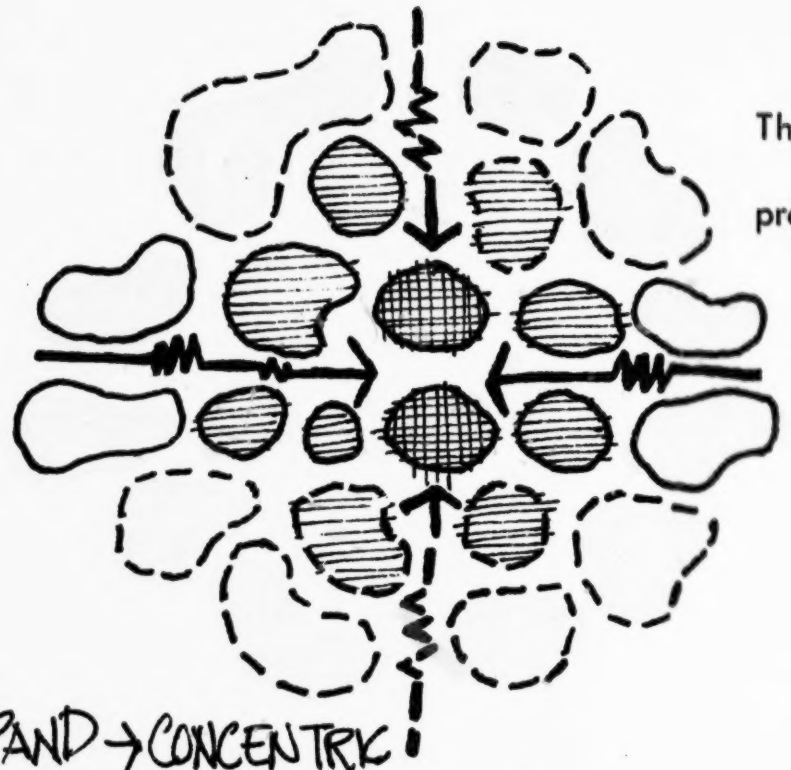


LINEAL

This concept represents basically the same theory of location of facilities according to function or discipline, outward from a central area on the basis of frequency of use (similar to concentric). The essential difference is in terms of physical form. The lineal concept is most applicable to a small college or university with a limited physical space, and one that may be subject to future growth.



BI-LINEAL

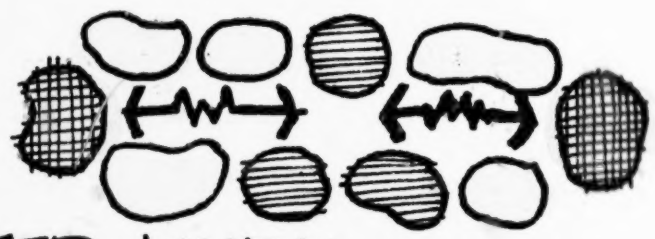


LINEAL → EXPAND → CONCENTRIC

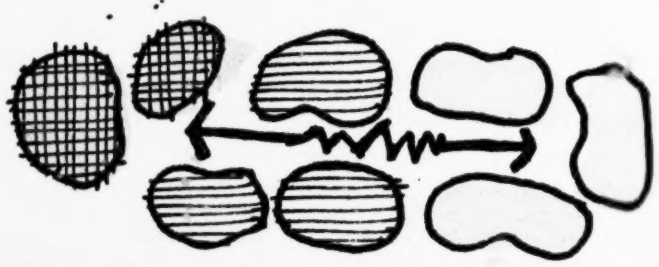
The future expansion based on this concept lends itself to two probable alternatives:

(1) By expanding vertically if ground space is limited. This consideration should be made at the initial construction stage in order to provide for additional floors;

(2) If additional land is available, this lineal configuration lends itself to conversion to a concentric form by expanding horizontally. Again, it is necessary to note that consideration for future development and expansion would have to be made during the initial planning stages.



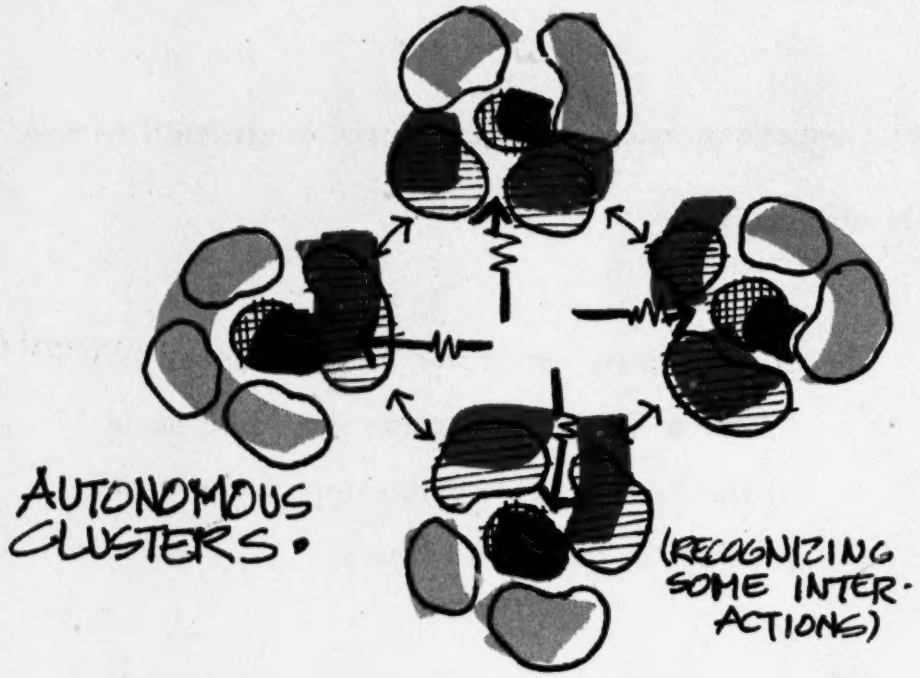
DECENTRALIZED LINEAL



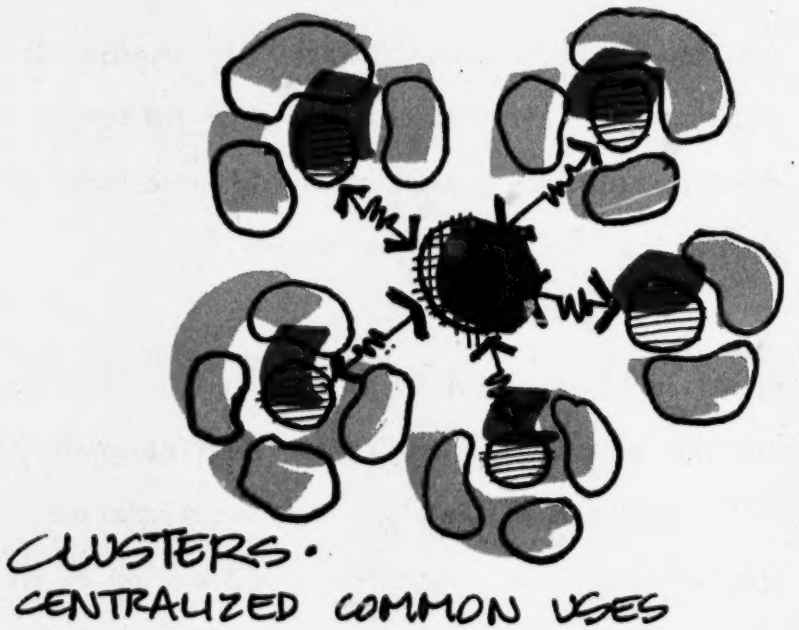
MODIFIED CENTRALIZED LINEAL

The lineal concept is often modified to locate the common use facilities at the points of entry rather than centrally. This is especially applicable when the entrances are well defined and require emphasis. Another modification might be the location of the common uses at the major entrance to the campus rather than in the middle or at both ends.

Cluster Concept

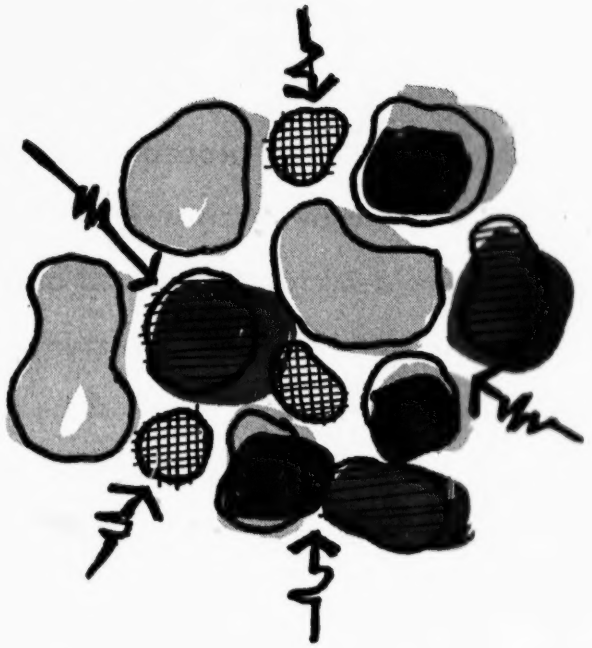


This concept focuses on the creation of individual, autonomous units that function independently from other units. However, relationship to the total campus structure may be achieved by centralizing the common uses. At the other end of the spectrum, autonomy may be enhanced by centralizing the common uses within each cluster or satellite. There are, of course, a variety of alternatives in a cluster plan that are between the two examples cited.



A typical application of this concept would be that the College of Engineering, for example, would occupy one cluster with all of the disciplines and functions required to attain a degree being provided in the cluster (e.g., Math, English, Business, etc.). However, library and administrative facilities may be located in a central common area accessible to all satellites.

Random Concept



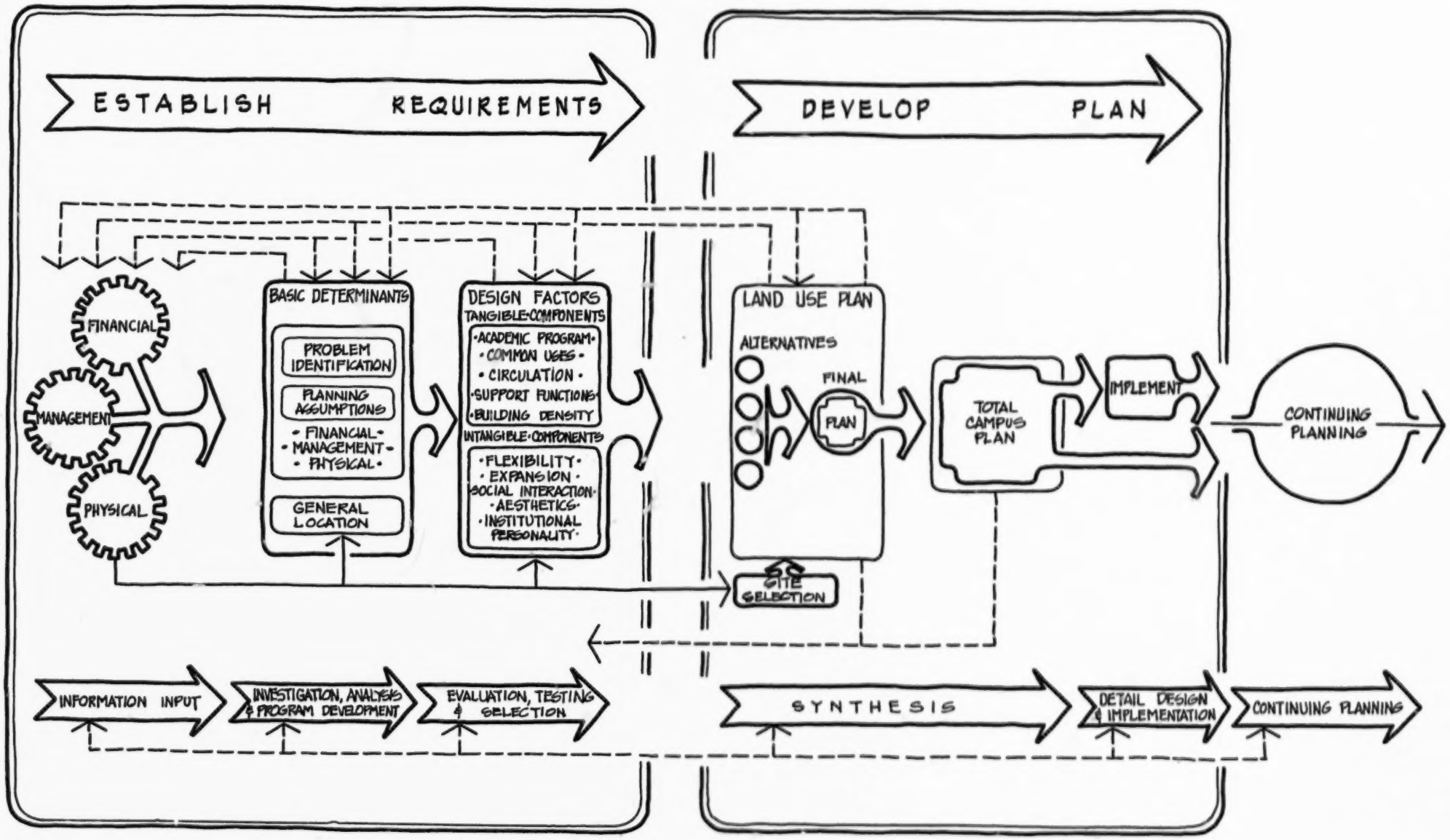
This concept is most frequently applicable to the existing campus and can be generally attributed to a situation in which a campus was developed without the benefit of a plan. If a plan did exist, the resulting random configuration illustrates either a poorly conceived plan or that an adequate plan was not adhered to. However, if well conceived, the random concept might be a deisrable approach for the new campus.

It is felt that the land use concept for any given institution will fit into one or a combination of the concepts previously discussed. The problem that exists is selecting that land use concept which would be best for any given institution. Obviously, this selection is affected and influenced by the studies of facilities, traffic, utilities, and by the results of management and financial studies. Thus, the need for a systematic and logical process of determining a desired land use concept for any given institution is identified.

LAND USE PLANNING PROCESS

The land use information discussed previously (illustrating the threefold context or framework within which decisions regarding physical planning take place) is interpreted into a procedural flow diagram, illustrated in Figure 8. This procedure recognizes the basic considerations relative to educational institutions. However, it is essential to note that the considerations identified are more within the realm of generalizations than absolute specifics. The specifics assume a significant role when the general process is applied to a particular university situation. It must be realized that each university situation is unique and requires specific interpretation of the relevant factors. The intent in presenting a land use planning model is to establish a general guideline or decision-making framework. Each consideration identified must still be appropriately analyzed, weighed, and evaluated when applied to a specific situation. The implications and applications of this process are discussed in greater detail in Volume III.

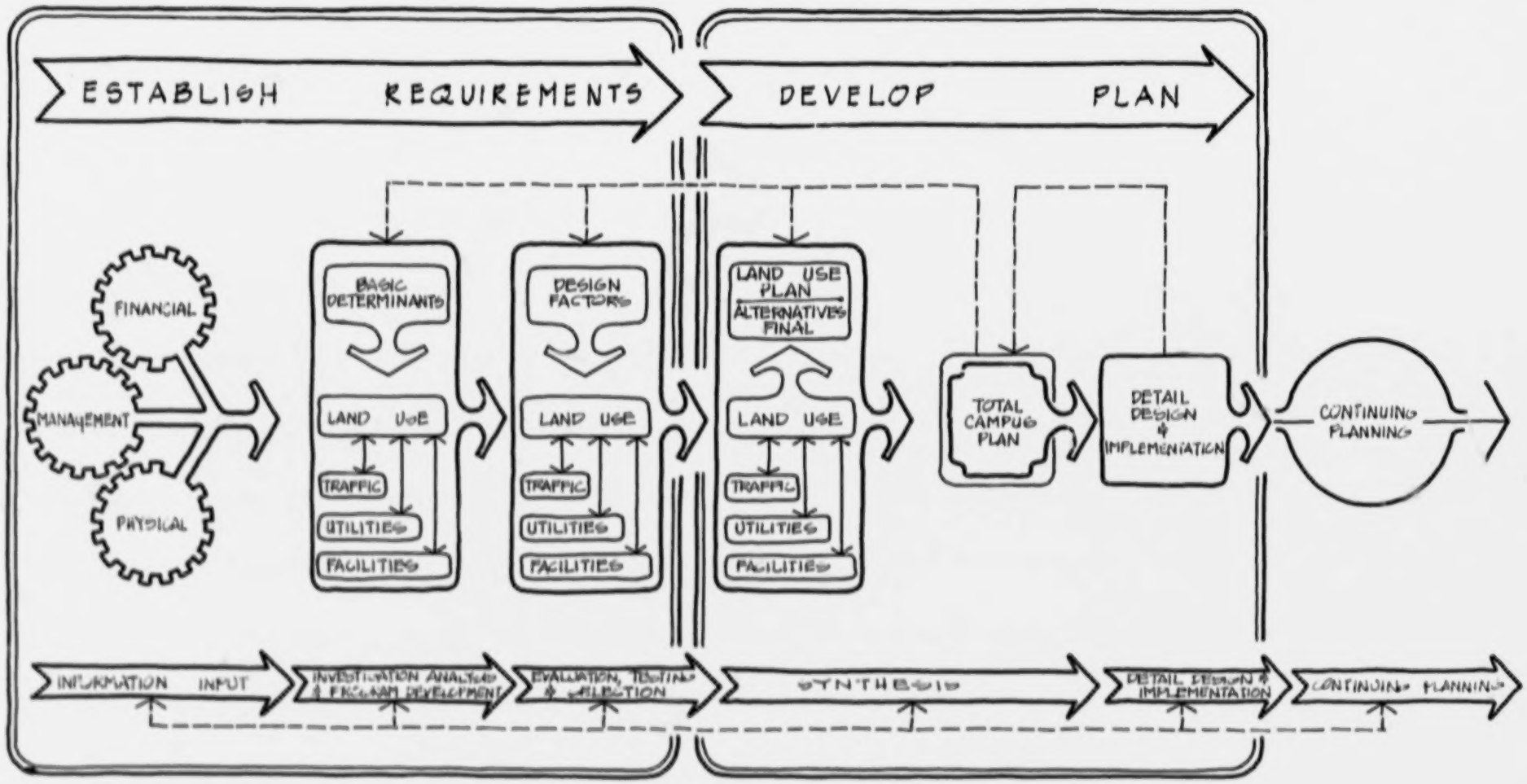
FIGURE 8 · LAND USE PLANNING PROCESS



PHYSICAL PLANT PLANNING PROCESS

The four major elements of Physical Plant Planning -- facilities, traffic, utilities, and land use -- are not to be construed as totally independent and individual processes. On the contrary, each process is an essential part of a larger process -- the Physical Plant Planning process. (Similarly, the Physical Plant Planning process is one part of the total college and university planning system, as illustrated in Figure 1.) The diagram on the following page (Figure 9) illustrates the merging of the four elements of Physical Plant Planning into a total process composed of interdependent parts. The relationship of parts in this hierarchy of planning processes might be best illustrated through an appropriate analogy -- a wheel. The functioning of a wheel is based upon the equal stresses and counter-balancing of the spokes, and the wheel is the operational unit of a larger piece of machinery. The particular wheel in this case is the Physical Plant Planning process, and there are four principal spokes that define the wheel -- facilities, traffic, utilities, and land use planning. If any of the spokes are weakened or eliminated, then the performance of the wheel will be proportionately reduced (based upon the capacity of the particular spoke). The total piece of machinery is the college and university planning system (which has a total of three wheels -- the other two being the Management Planning process and the Financial Planning process).

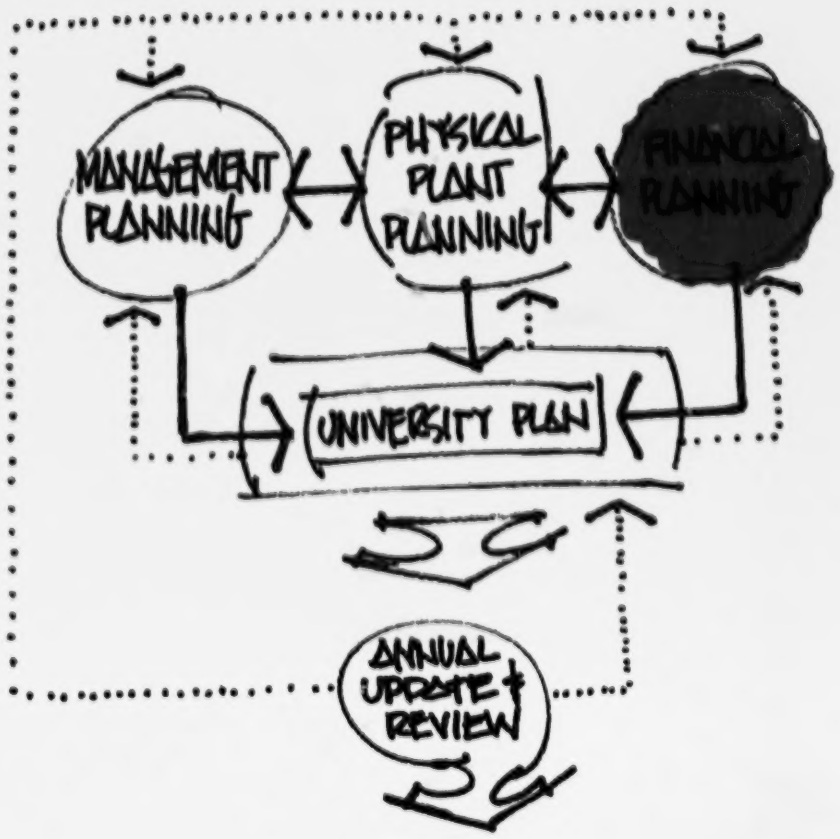
FIGURE 9 · PHYSICAL PLANT PLANNING PROCESS



The Physical Plant Planning process illustrated is a generalized decision-making framework or guideline. It is essential that flexibility be built into such a model so that the specifics of a particular university situation may be appropriately applied and realized. Flexibility becomes the key procedural criterion. Timely inputs and feedback, or an iterative process is the response to this need. Therefore, the process is not based upon a singular directional flow (from phase 1 →2→3) but upon a multiple directional flow (from phase 1→2→1→2→3→2→1→3, etc.), in addition to appropriate inputs of relevant information.

Each major planning function, or element, contributes to the ultimate physical plant plan, and it is necessary that they are conducted simultaneously in order to insure consistency. Decisions in each individual process will produce implications upon decisions relating to the other processes and the total plan. Consistency, based upon a recognition of the interdependency of these individual processes, must be achieved. This consistency is based upon a well-coordinated total effort that is comprised of integrated and cooperative parts. As the planning process progresses through each phase, it is dependent upon inputs and interactions between land use, traffic, facility and utility considerations. This insures that each significant decision involves all the relevant determinants.

FINANCIAL PLANNING



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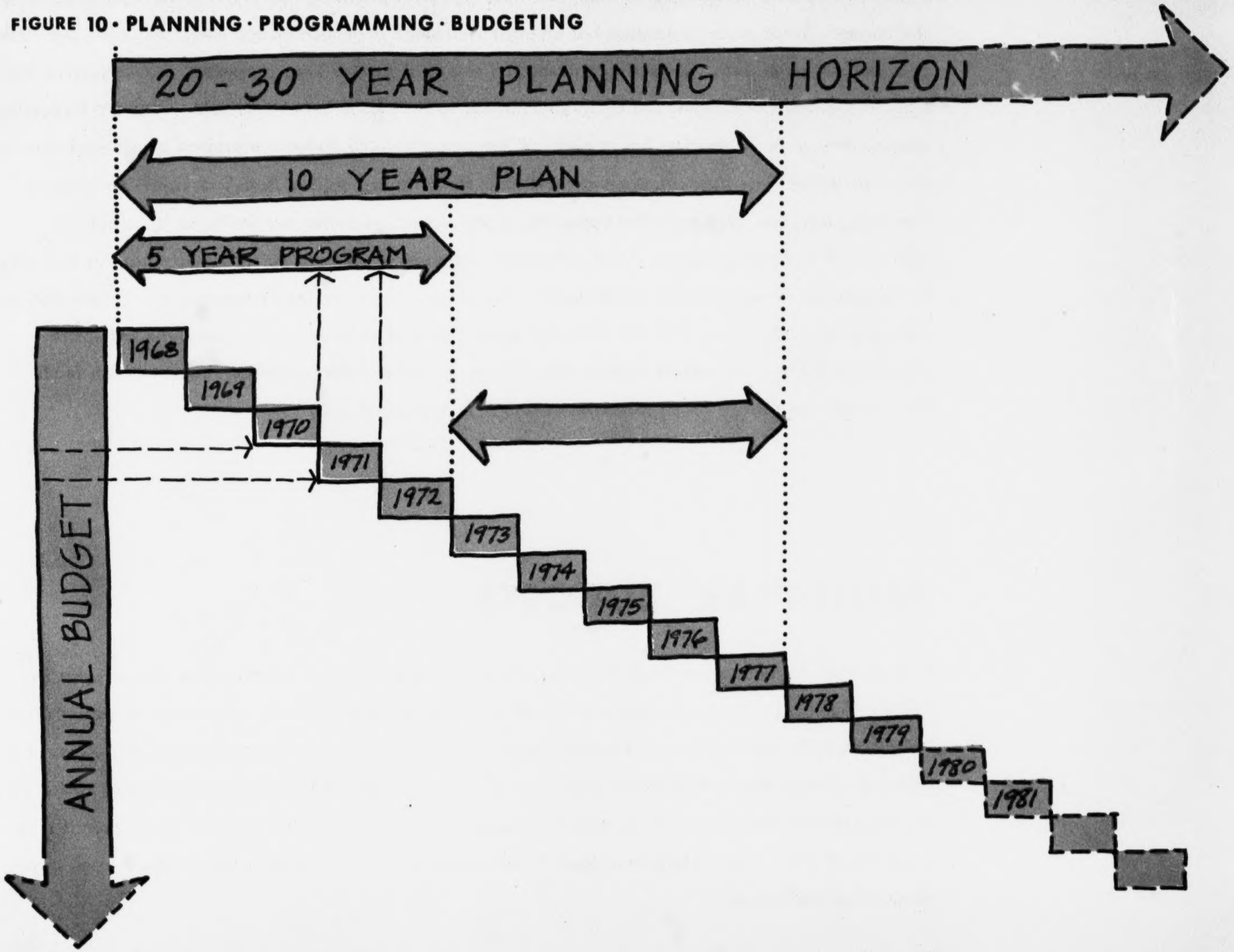
While it is seldom recognized as such, the most powerful planning tool familiar to organizations is the budget. Since no organization has an unlimited stock of human or economic resources available to pursue its objectives, budgeting becomes an essential fact of life. However, the restrictive and fiduciary aspects of budgets are often emphasized to the exclusion of that role which the budgeting process may play in shaping future plans of the organization. Budgets are often considered only in terms of the ceilings they place on expenditures for different object, fund, or line-item classifications. But, the very fact that upper limits are placed on dollar expenditures is defacto an exercise of a planning option. Most, if not all, organizations have numerous alternatives that may be considered in arriving at final budgeting decisions. More (or less) resources may be devoted to one, several, all, or none of the different organizational units depending upon the economic constraints facing the overall organization. It is, therefore, the budgeting process which lends final shape and reality to all planning efforts that have gone before.

MULTI-YEAR BUDGETS

It is common for educational institutions to develop annual budgets for only one or two years in advance. This short-range budget consideration gives no assurance that long-range objectives may be attained. It also fails to give proper attention to the total cost of a program (or plan of action) that may extend over a five to ten year time span. A program which may have a modest initial cost (during the first one or two years) may call for significant expenditures several years later if it is to be maintained. The failure to recognize this long-term cost may seriously jeopardize the operation of an institution.

FIGURE 10 • PLANNING · PROGRAMMING · BUDGETING



Thus, the financial aspects of an institutional plan must be studied from a long-range viewpoint just as the Management and Physical Plant development has been treated in the previous sections. The annual budgeting process should be related to the total planning process as illustrated in Figure 10. An overall planning horizon can be established which may extend from 20 to 30 years, and, within this planning horizon, specific programs of from five to ten years in length may be developed to attain desired objectives of the institution. The annual budgets then provide the "stepping stones" to move toward completion of program objectives.

FINANCIAL EVALUATION

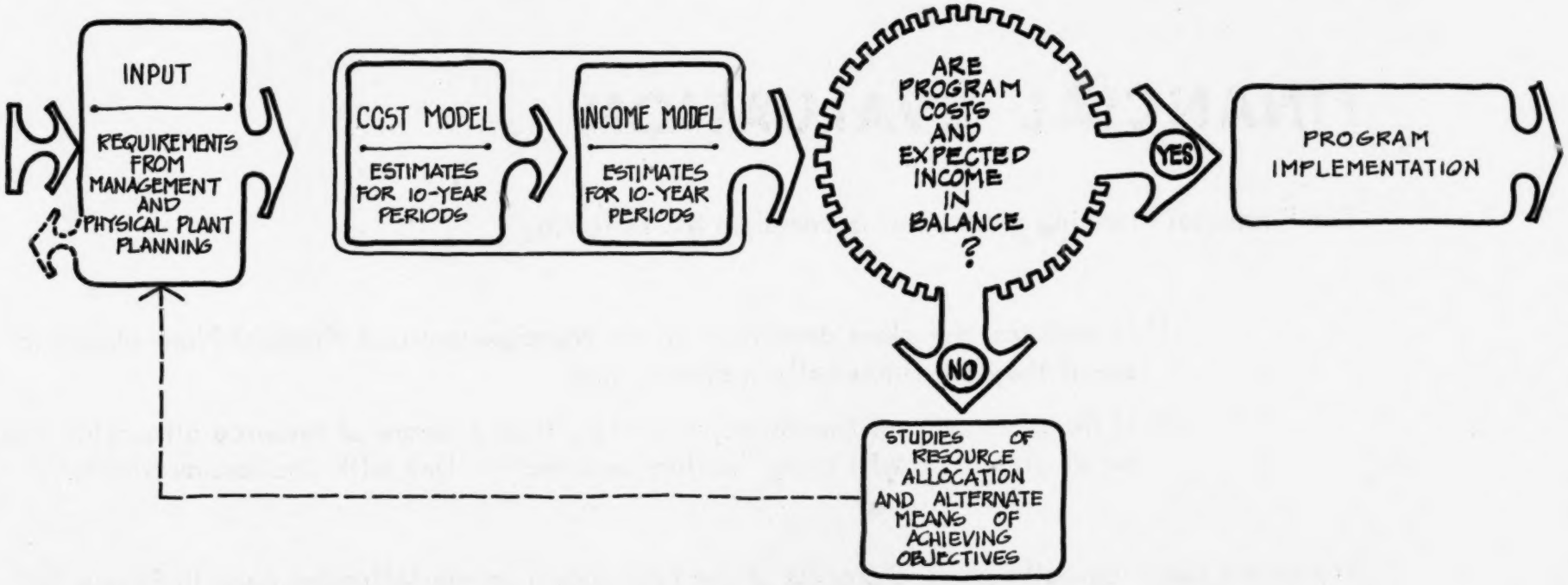
The Financial Planning phase must accomplish the following:

(1) It must test the plans developed in the Management and Physical Plant phases to see if they are financially realistic, and

(2) If the plans are not financially realistic, then a means of resource allocation must be sought which will bring "dollars required" in line with "dollars available".

The above tasks logically imply a process of the type shown on the following page in Figure 11. This process demands a thorough analysis of projected program costs and anticipated income. If costs exceed income, then a recycling of the planning process is required in order to consider modification of objectives or alternative means of attaining the selected objectives that would achieve a financial balance.

FIGURE 11 · FINANCIAL PLANNING PROCESS



COST ESTIMATION

It is very vital that an institution has a good understanding of what it costs to provide for its continuing operation. These costs can be considered in two broad categories -- (1) Operating Costs and (2) Capital Improvement Costs. The operating costs will include the budgets of the various organizational units plus costs for such items as utilities (power, gas, etc.), janitorial service, and plant maintenance.

The planning reports for the various organizational units of an institution will provide annual operating costs for these units. These costs include personal services (faculty-staff salaries), capital expenditures (annual equipment purchases), and general operating expenses.

Care should be taken to include the costs of utilities, janitorial services, and maintenance for these costs will magnify significantly with expanding programs. Enrollment increases will generate the need for additional space which, in turn, increases the annual cost for utilities, janitorial services, and maintenance.

The capital costs for an institution result from the costs of adding new buildings, purchasing equipment, and making modifications to existing buildings. These costs should be reduced to annual requirements for one, five, and ten years in the future.

INCOME ESTIMATION

After establishing program costs and multi-year budgets, an institution must develop a prediction of its income for the same period. This income would include such items as:

Tuition	Grants
Endowments	Research Contracts
State and Federal Support	Other Sources

The income picture must also be projected over a multi-year period for comparison with projected costs.

PLANNING·PROGRAMMING·BUDGETING

The Financial Planning phase might be characterized as a two-stage process. The first pass at predicting requirements and converting these requirements to cost would generally be of an unconstrained nature. The organizational units are asked to consider desired objectives, make plans to achieve these objectives, and to estimate the resource requirements necessary to attain these objectives. Data on requirements would flow freely from all units of the university permitting an excellent overview of desired plans of action and resource requirements.

This unconstrained approach to resource requirement prediction, however, can be expected to produce costs in excess of anticipated income. This situation requires a recycling of the planning process and the consideration of techniques that will bring program costs into balance with anticipated income.

There are four basic approaches to achieving this cost-income balance. These are listed as follows:

(1) Development of increased income;
(2) Modification or elimination of some objectives;
(3) Utilization of alternate means of obtaining objectives, and
(4) Combinations of the above.

Each approach must be carefully analyzed as to its effect on the realization of the total plan.

The development of additional income needs may dictate new strategies and the identification of new income sources. The modification or elimination of objectives will require a priority analysis and priority assignment relative to desired objectives.

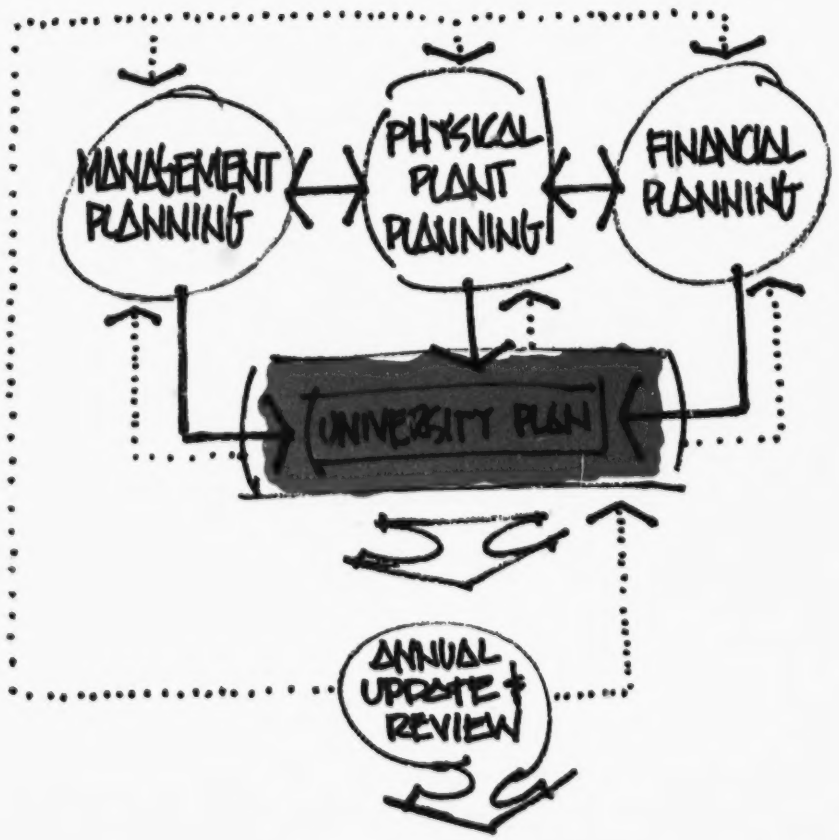
The utilization of alternate means to obtain objectives generates the need for a thorough analysis of existing and planned operations. For example, alternate means of obtaining objectives in teaching with a reduction in program costs are illustrated below:

(1) Changes in student-teacher ratio;
(2) Changes in the amount of space allocated to various programs;
(3) Utilization of graduate assistants and junior faculty members;
(4) Increased use of television and other teaching aids.

The above teaching alternatives may provide means to decrease program costs, but also may reduce the effectiveness of the program. Thus, cost-effectiveness or cost-benefit analyses must be given careful consideration.

This entire process of decision-making and resource allocation has been formalized in a technique called a Planning-Programming-Budgeting System (PPB System). This system was developed for application to management of the Department of Defense and has gained widespread recognition as a valuable management tool for all organizations. A detailed discussion of Financial Planning and of the potential application of Planning-Programming-Budgeting to the problems of resource allocation in institutions of higher education is presented in Volume II.

TOTAL UNIVERSITY PLAN



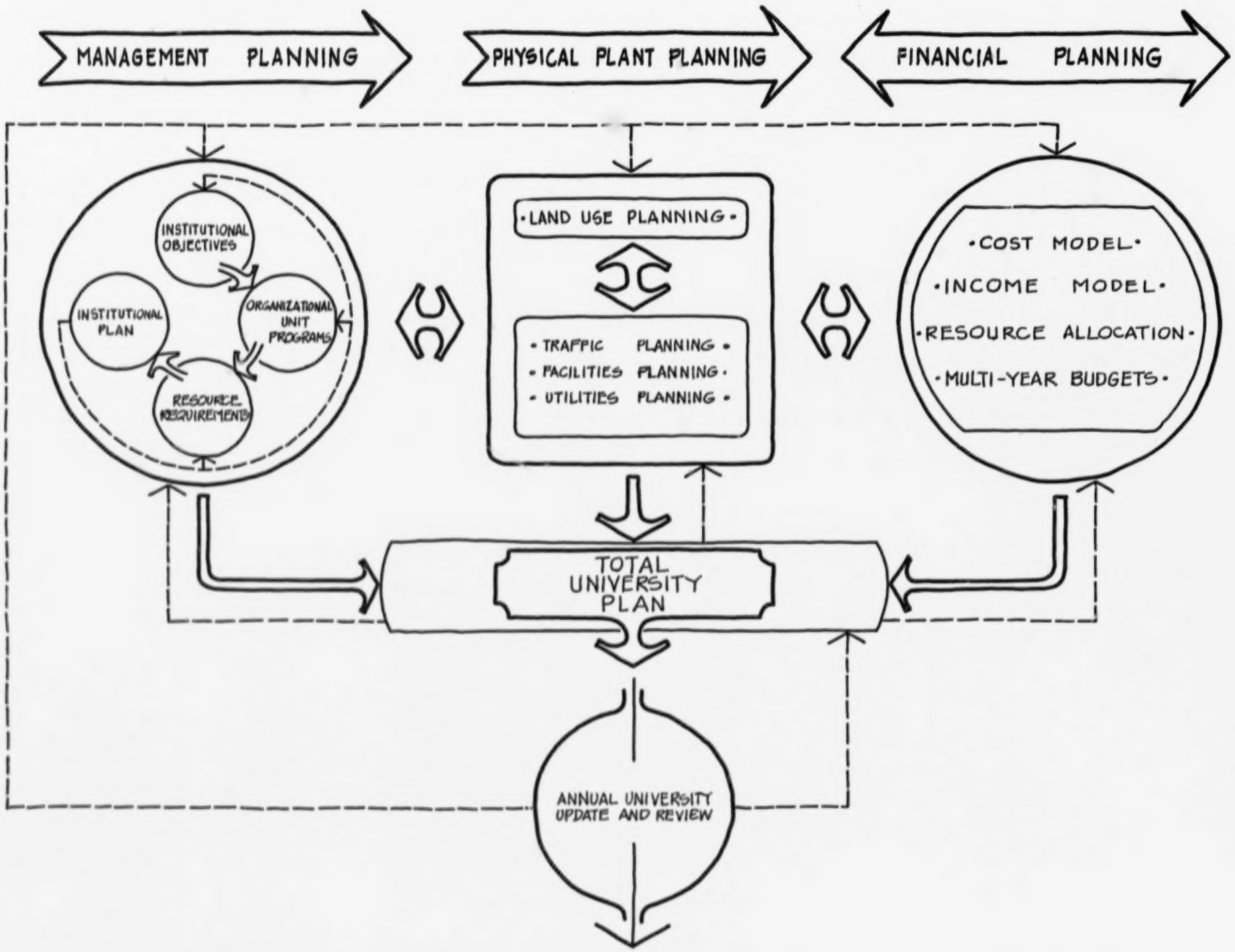
The previous sections have outlined the essential elements of a planning process namely (1) Management or Program Planning (2) Physical Plant Planning, and (3) Financial Planning. These elements must now be considered as integrated elements of a total system that will produce a master plan and a continuous planning process for a university. This system is illustrated on the following page in Figure 12.

The planning process has been presented in the general sequence that a total plan must develop. Objectives are set, programs are developed, resource requirements are determined, and, finally, a financial appraisal is made to determine if the plan is realistic. This process will no doubt require iteration to develop a strong assurance that the plan developed is capable of completion.

The completion of the total planning process can be expected to produce the following elements of a total university plan:

(1) Statement of Objectives for the University
(2) Individual Plans for all Organizational Units
(3) Total Facilities Plan, including
    (a) Land Use Plan
    (b) Utilities Plan
    (c) Traffic Plan
    (d) Facilities Plan
(4) Financial Plan, including
    (a) Cost Estimation Model
    (b) Income Estimation Model

FIGURE 12 · TOTAL UNIVERSITY PLAN



The basic elements of this plan can be summarized within the cover of a total university report. In addition to this final summation, it is important that, upon completion of the total university plan, every organizational unit of the university has its own plan which is an integral part of a total plan. This produces a coordinated and informed effort at all administrative levels which is directed toward the realization of desired university objectives.

Thus, it can be seen that the planning system which has been developed is, in fact, a management information system that provides data for decision-making at all administrative levels. To be effective such a planning system must be well organized, well staffed, and dynamic. These final aspects of the total system will be covered in the next section.

CONTINUOUS PLANNING SYSTEM

96/97

The emphasis of this section is upon the dynamic aspects of planning and the need for the recognition of the planning responsibility at the top level of administration. Many excellent planning efforts have failed to produce significant results because too much emphasis was placed upon developing a "plan" and not a "planning process" and because of a lack of assigned responsibility for continuous planning.

DYNAMIC PLANNING

In a Continuous Planning process, three basic tasks should be accomplished at least once a year. These are as follows:

(1) An evaluation must be made of the activities of each organizational unit. This evaluation will compare actual activities during a given time period with the activities projected for that time period. This evaluation will consider such questions as:
   (a) Is progress as great as expected?
   (b) Were the projection factors correct?
   (c) Are additional resources needed?
   (d) And other pertinent questions relative to the accuracy and effectiveness of the planning process.

(2) The projection of activities and requirements for an additional future year must be completed. This projection permits the maintenance of a multi-year planning period.

(3) Objectives must be re-examined in the light of new conditions. Basically three questions must be asked and answered.
   (a) Are the objectives still desirable?
   (b) Are the objectives still feasible?
   (c) Are new objectives needed?

   These questions permit the institution to modify its plans and keep abreast of new developments.

The planning reports for the various organizational units are designed to accomplish the previous tasks. Both historical and projected data are maintained for comparison, and projected activities and requirements may be added to the report each year.

Annual planning activities for a continuous planning system are shown in Figure 13. The various tasks are described as follows:

Plan Review and Projection by Academic Departments - Review of actual versus projected activities and development of projected activities and requirements for future years.

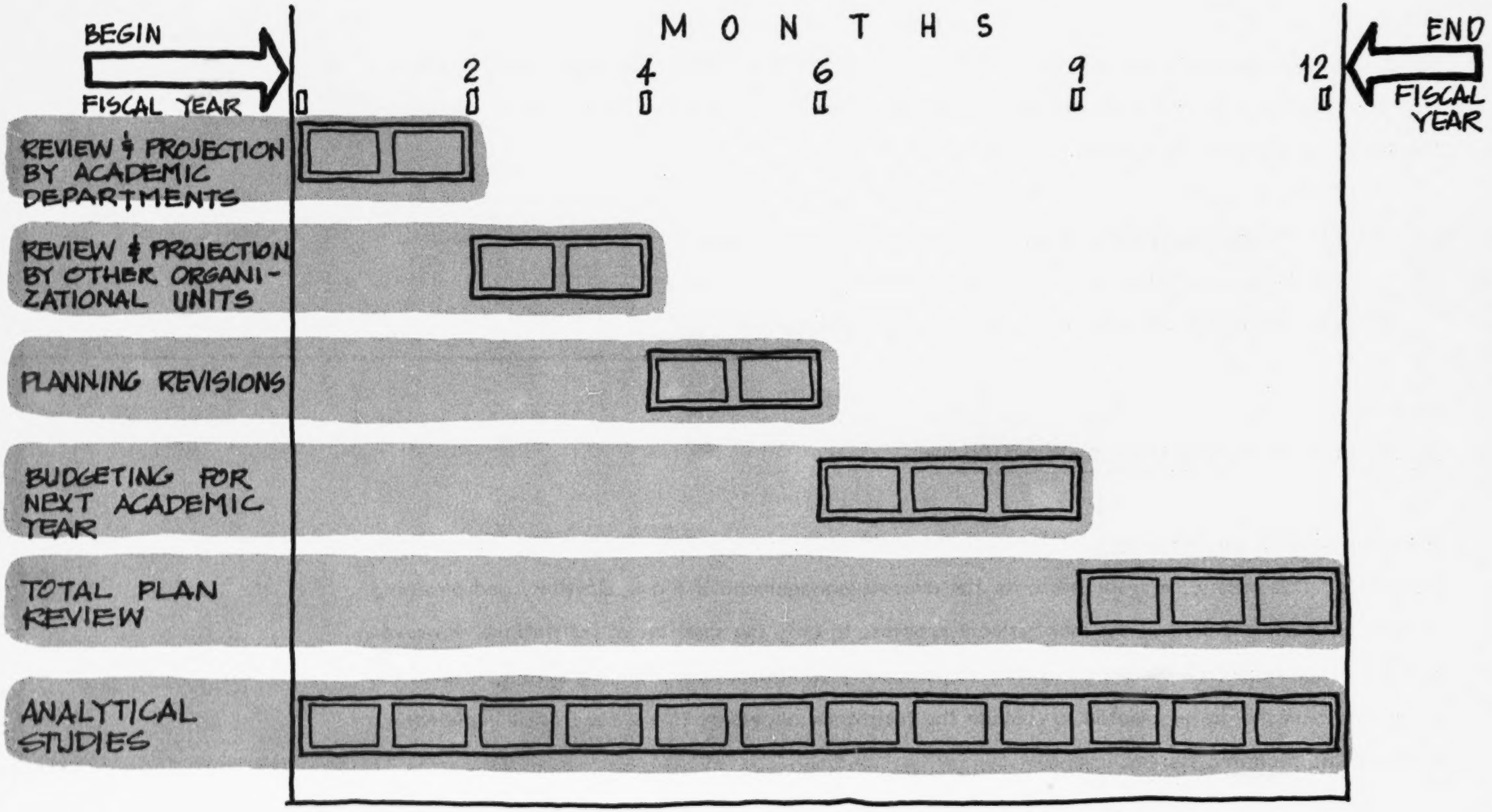
Plan Review and Projection by Other Organizational Units - Similar to the first task but utilizing new data developed by the academic departments.

Planning Revisions - Merging of the results of the organizational units' reviews and projections and modification of plans as may be required by new objectives.

Budgeting - Development of a budget for the next fiscal year.

Plan Review and Analytical Studies - Additional plan review and analytical studies that may be required.

FIGURE 13 • ANNUAL PLANNING ACTIVITIES



ORGANIZATION

Basic to the success of the planning system described in this report is the development of a planning organization within the administrative framework of the institution. Consideration must, therefore, be given to the following questions:

(1) Where should the responsibility for planning be located?
(2) What should be the function of a planning organization?
(3) What staff are required for a planning organization?

LOCATION OF PLANNING RESPONSIBILITY

The responsibility for planning must logically be assigned to the chief administrative officer of the institution. This official is responsible for the overall management of the institution, and planning is an inseparable element of the management process. In only the smallest of institutions, however, will the chief executive officer have time to personally administer the planning system. Therefore, a staff position should be created to provide the assistance necessary to the successful implementation of the planning system.

Although the chief executive officer must assume the overall responsibility for planning, this does not imply that other organizational units are not involved in the total process. In fact, the planning system developed in this report requires that each level of management in the institution

play a vital role in the planning process. Each organizational unit will develop its own plan which will be coordinated with and integrated into the total university plan. This participation in the planning process will also provide a very desirable communication system between all administrative levels.

It will be the responsibility of the chief executive officer (through his planning staff) to direct and coordinate all of the planning efforts and to merge them into an integrated plan of action. This final plan of action will then become a management information source for top-level decisions regarding both day-to-day and long-range operations of the university.

The assumption of the planning responsibility by the chief executive officer will provide other important advantages for the planning functions as listed below:

(1) Top-level perspective of the total university operation;

(2) Independence from the influence of any single facet of the university;

(3) Top level support for all responsibilities it must assume and carry out;

(4) Focal point for presenting management information data for top-level management decisions.

The title of the individual who will head the planning office will vary depending upon the size and policies of the institution involved. For a large university, the position should carry the title of Vice-President while at a smaller institution the position may be titled Assistant to the President or Director of Planning. In a very small institution, the position might desirably be filled by a part-time faculty member.

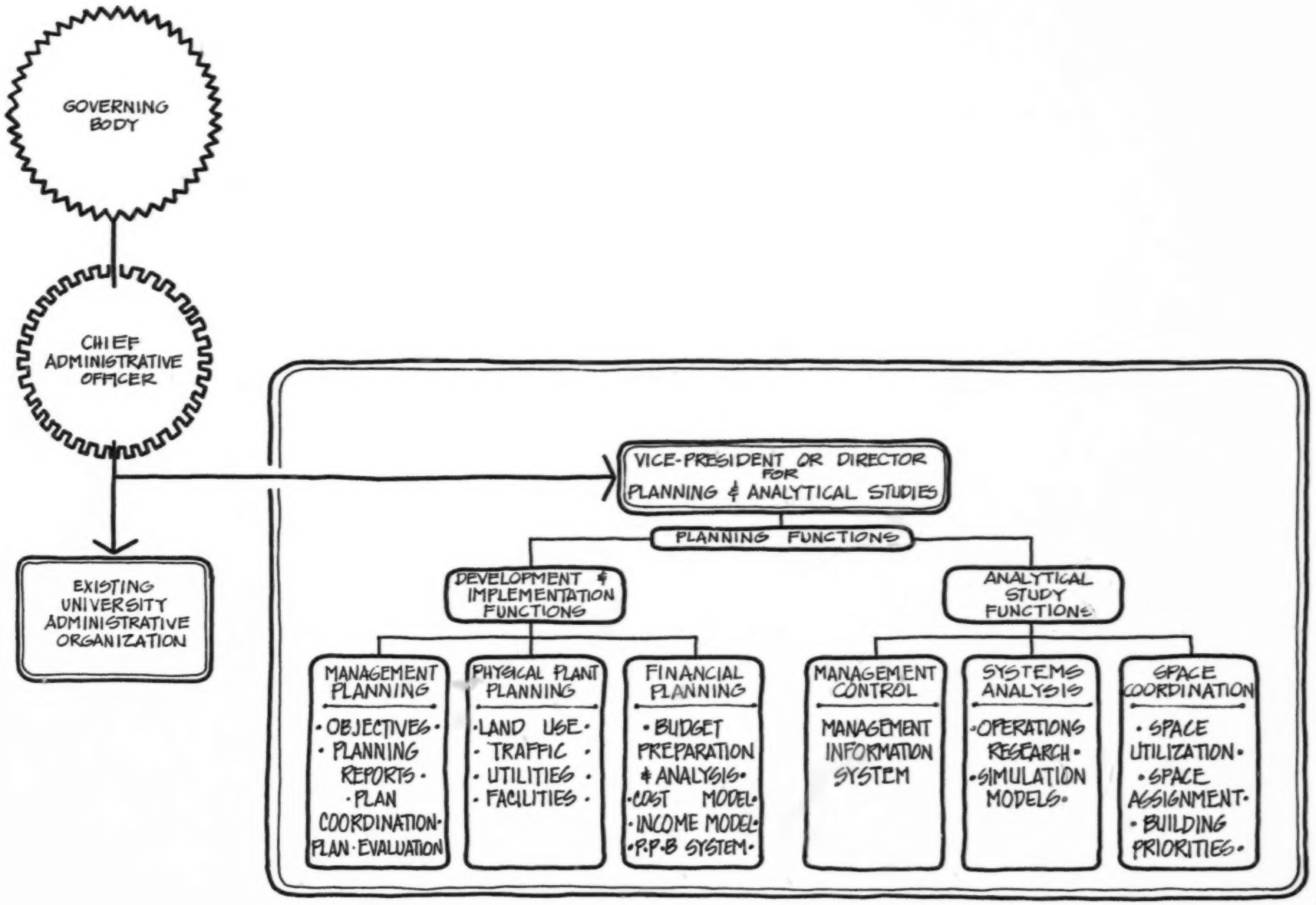
FUNCTIONS

The functions of a planning position should include development and implementation and analytical studies. The development and implementation function would, of course, include coordination of the total planning effect and surveillance of progress toward selected objectives.

The analytical studies function provides for the conduct of studies necessary to the overall management and planning process. Examples of such studies are space utilization, cost analyses, operations research, etc. This function would include the responsibilities of an office of institutional research. The usefulness of such an office could be greatly increased by coordinating and integrating it with the management and planning function.

An organizational diagram showing the recommended location and functional structure of a planning and analytical studies office is provided in Figure 14.

FIGURE 14 · ORGANIZATIONAL CHART · PLANNING OFFICE



STAFF REQUIREMENTS

The staff requirements would vary depending upon the size of the institution involved. In general, the planning office should be headed by a person with the following qualifications:

(1) Knowledge of management planning techniques acquired through training and experience in the use of modern scientific management;

(2) Knowledge of the organization and management of academic institutions;

(3) Ability to communicate effectively and work with other people in a staff or service capacity;

(4) Understanding of the financial management and economics of the operation of an educational institution;

(5) Working knowledge of architecture, engineering, and construction methods and costs;

(6) Ability to develop systems and procedures for the accumulation, processing, and analysis of management control information;

(7) Familiarity with the application of computer technology and programming for management systems.

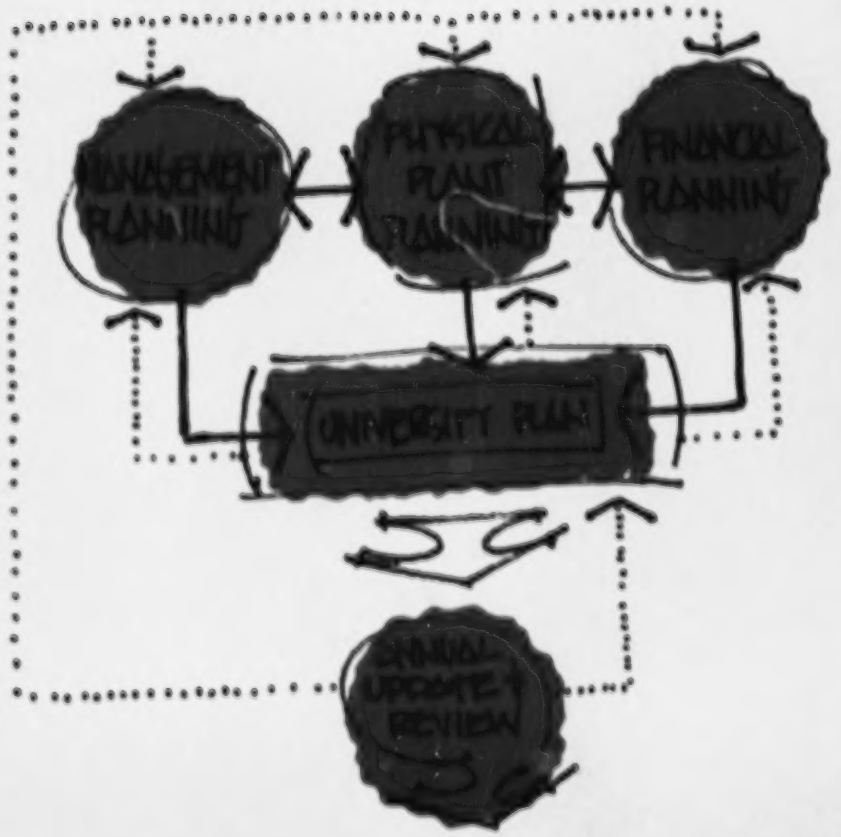
It should be emphasized, however, that the planning system previously defined produces the need for a rather wide range of specialized talents. Just as the proposed planning process requires a system concept, it is also necessary to view the work of a planning staff as a team effort. Several disciplines should be represented on the planning team to provide the required talent. The more pertinent of these required disciplines are as follows:

Management	Architectural and Environmental Planning
Systems Analysis	Engineering
Economics	Computer Science

Only the larger universities could be expected to assemble a planning staff with the capabilities previously described. Smaller institutions should also utilize the same type of talent by employing consultants to provide the specialized talents required to develop various aspects of the planning process. The work of consultants, however, should be coordinated by an institutional planning office which would maintain the overall responsibility for the planning effort.

A detailed presentation on the organization and operation of a planning office is presented in Volume II.

SUMMARY


MANAGEMENT PLANNING
PHYSICAL PLANT PLANNING
FINANCIAL PLANNING
UNIVERSITY PLAN
ANNUAL UPDATE REVIEW

This volume has sought to outline a system for effective planning in colleges and universities. This system integrates Management and Program Planning, Physical Plant Planning, and Financial Planning into a total and singular planning process. This process is designed to support institutional management and decision-making at all administrative levels. Specific details on the techniques of the planning system will be presented in additional volumes as referred to throughout the text.

Computers offer a significant tool to aid the planning system defined by this study, and their use has been envisioned and implied in many aspects of the system. The planning system is not dependent, however, upon computer utilization as all of the techniques and analyses can be accomplished manually.

Planning techniques for colleges and universities will become more sophisticated during the next few years. The utilization of computers and operational analysis techniques have much to offer in this regard. It was desired that the planning system developed be adaptable to a rather wide range of institutions and that the degree of sophistication with regard to computers and other scientific management techniques be dependent upon the abilities and facilities of the individual institutions. It is believed that the system provides an easy starting point in institutional planning and can be readily adapted to more sophisticated techniques as desired.

In summary, the basic conclusions of this study are presented as follows:

(1) The challenges that lie ahead in higher education demand an ever improving system of administration. Good planning should become a keystone of institutional management. The prevalent and narrow concept of "campus planning" must be broadened to include a concept of Management and Program Planning, Physical Plant Planning, and Financial Planning as a total system. These essential elements of a total planning system must be integrated into a process capable of supporting effective institutional management and decision-making at all administrative levels.

(2) The creation of a top-level administrative position of planning and analytical studies is necessary to the successful implementation of effective planning in colleges and universities. Such a position should be created as a staff position which would report directly to the Chief Administrator to assist him in the management and planning of all facets of institutional operation.

(3) In the past, institutional planning has been considered more of an art than a science. However, this study has documented the fact that it is possible to develop and implement a generalized systematic process of planning that can be supported by a strong quantitative data base.

(4) Finally, the concept of a dynamic and continuing "planning process" must be substituted for the inadequate concept of a static "plan". Annual reviews and updating are necessary to keep the plans and programs of an institution abreast of and responsive to the rapidly changing environment of modern times.

ADDITIONAL VOLUMES

Volumes II through V supplement the basic material presented in this volume. An outline of these volumes is as follows:

VOLUME II - MANAGEMENT AND FINANCIAL PLANNING

I. Introduction
   - A. Planning System
   - B. Management and Program Planning
   - C. Financial Planning
   - D. Organization for Planning

II. Institutional Objectives
   - A. Fact-Finding Study
   - B. Preliminary Objectives
   - C. Review and Modifications

III. Organizational Unit Plans
   - A. Program Units
   - B. Support Units

IV. Planning Report - Program Implementation Units
   - A. Format
   - B. Historical Section
   - C. Projections
   - D. Program Requirements

V. Planning Report - Program Support Units

VI. Management and Program Planning Summary

VII. Organization for Planning
   - A. Basic Considerations
   - B. Development of Planning Organization
   - C. Staffing of Planning Organization

VIII. Cost Model

IX. Income Model

X. Planning - Programming - Budgeting
   - A. Definition
   - B. Program Concept
   - C. Program Requirements
   - D. Resource Allocation

VOLUME III - PHYSICAL PLANT PLANNING • LAND USE AND TRAFFIC

I. Introduction

A. Land Use
B. Traffic

LAND USE PLANNING SECTION

II. Introduction

III. Basic Determinants - Information Inputs
A. Management
B. Financial
C. Physical

IV. Basic Determinants - Investigation, Analysis and Program Development
A. Problem Identification
B. Planning Assumptions

V. Design Factors - Evaluation, Testing and Selection
A. Tangible Design Factors
B. Intangible Design Factors

VI. Land Use Plan - Synthesis
A. Land Use Scales
B. Land Use Alternatives
C. Land Use Plan

VII. Detail Design and Implementation

VIII. Continuing Planning

TRAFFIC PLANNING SECTION

IX. Introduction
- A. Conditions
- B. Basic Elements

X. Access
- A. Street System Inventory
- B. Traffic Characteristics
- C. Traffic Assignment

XI. Internal Circulation
- A. Street Inventory
- B. Characteristics of Pedestrian Movement

XII. Parking
- A. Supply Inventory
- B. Characteristics Study
- C. Future Types

XIII. Special Events
- A. Attendance
- B. Routing
- C. Control Coordination

XIV. Traffic Plan
- A. Analysis of Results
- B. Construction of Facilities
- C. Control Plan

VOLUME IV - PHYSICAL PLANT PLANNING • FACILITIES STUDIES

I. Introduction
   A. Problem
   B. Required Studies
   C. Presentation
II. Inventory of Existing Facilities
   A. Requirements
   B. Facilities Manual - U.S. Office of Education
   C. Special Requirements
III. Utilization of Teaching Facilities
   A. Considerations
   B. Utilization Measurements
   C. Reporting
IV. Estimation of Space Requirements
   A. Teaching Facilities
   B. Non-Teaching Facilities
V. Utilization of Non-Teaching Facilities
   A. Considerations
   B. Organizational Unit - Space Inventory
   C. Proration System
   D. Utilization Evaluation
VI. Automated Assignment of Teaching Facilities
   A. Master Schedule Construction
   B. Student Sectioning
   C. Summary
VII. Quality Analysis of Existing Facilities
   A. Physical Analysis
   B. Cost Analysis
   C. Intangible Analysis
   D. Rating System
VIII. Residential Housing Study
   A. Single Students
   B. Married Students
   C. Faculty-Staff
   D. Community Resources
IX. Facilities Planning System
   A. Flow Diagram
   B. Output

VOLUME V - PHYSICAL PLANT PLANNING • UTILITY STUDIES

I. Introduction

II. Energy Utilities
- A. Chilled Water
- B. Water Heating Systems
- C. Steam
- D. Condenser Water
- E. Electric Lighting and Power

III. Distribution Systems
- A. Central Utilities Plant
- B. Central Plant Distribution Systems
- C. Controls for Central Utilities Plants
- D. Total Energy Plants

IV. Service Utilities
- A. Water
- B. Sewerage System
- C. Surface Drainage
- D. Domestic Hot Water
- E. Compressed Air

V. Communication Systems
- A. Telephone Systems
- B. Telegraph
- C. Radio
- D. Pneumatic Tube Systems
- E. Clock and Signal Systems
- F. Data Reclaim Systems

VI. Summary